TRANSACTIONS

OF

THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS

VOL. XVI.

SIXTEENTH ANNUAL MEETING

NEW YORK, JANUARY 18-20, 1910

SUMMER MEETING

ST. LOUIS, MO., JUNE 30-JULY 1

PUBLISHED BY THE SOCIETY
AT THE OFFICE OF THE SECRETARY
NEW YORK CITY

OFFICERS, 1910-1911

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CCIX.

THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS,

SIXTEENTH ANNUAL MEETING AT

ENGINEERING SOCIETIES' BUILDING, NEW YORK CITY, N. Y.,

January 18-20, 1910.

FIRST DAY—AFTERNOON SESSION.

(Tuesday, January 18, 1910.)

The meeting was called to order at 2.50 P.M. by President Snow.

The Secretary read the list of persons elected to membership since the last meeting.

S. A. Anderson, Jr.	Member.
S. Morgan Bushnell	"
Frank T. Chapman	"
E. L. Ellingwood	"
M. L. Foote	"
A. Edson Hall	"
Ralph B. Hayward	"
Charles D. Kirk	"
William F. McDonald	"
William A. Shorb	"
Abner E. Werkhoff	"
Edward L. Wilson	"

Frank Schreidt .... Associate.
Laurance C. Jost .... Junior
Murray J. Marvin .... "

The Secretary then called the roll partially, and announced that there was a quorum present.

The President's Annual Address was read by President Snow.

PRESIDENT'S ADDRESS.

This, the sixteenth annual meeting of the American Society of Heating and Ventilating Engineers, will differ materially from others in that most of our time will be devoted to the hearing and discussion of committee reports.

Our former president, in his address a year ago, outlined a plan for making this a review meeting. Based on his recommendation and the vote of the Society, committees were appointed, covering a wide variety of subjects, to review our proceedings and prepare a digest of what has appeared in papers and discussions bearing on those subjects. The reports of these committees will show us not only what has been done by the Society, but will bring to our attention the branches that need developing, so that we shall be able to intelligently lay out a course of work for which a demand may have been shown to exist.

Aside from the review committees we have a new one, called the publicity committee, with its central committee of three and its subsidiary members in many of the States. It has been felt that the work and aims of this Society have not received as prominent mention in other than the engineering and trade press as should be the case. It is hoped that this committee will devise ways, and that the Society will provide means whereby this apparent deficiency will be overcome.

It is important not only to us as members of this Society that its work should have the broadest possible publicity, but it is equally, if not more, important to the public that the facts brought out at our meetings in reference to methods of heating and ventilation should have the desired dissemination.

Our committee on compulsory legislation has been active in

securing data from the various States and is pushing this important work.

The committee on which, perhaps, the most work has devolved is the one engaged in devising a method for rating boilers. This is a broad subject, and one which requires careful study. This committee, which is practically a union of two committees, has been engaged in this work for months, a tentative report was presented at the summer meeting; further investigation of the subject has been made since that time, and the report to be presented at this meeting will merit the most careful consideration and the fullest discussion on the part of our members.

The knowledge that so many committee reports were to be presented at this meeting has probably deterred members from preparing and submitting original papers. A perusal of our records shows that during the fifteen years 143 papers have been presented before this Society, an average of less than 10 papers per year. Of these 143 papers 74, or more than one-half, have been presented by only 12 of our members, the other 69 having been presented by 53 persons, some of whom were non-members. This shows that many of our members have as yet made no contribution through professional papers of their knowledge and experience. A greater number of papers is needed. If too many are presented for it to be practicable to have them read in full at meetings, they may be read by abstract as in other societies and published in our proceedings for the benefit of members.

I look upon this organization as a sort of co-operative society. Members have a right to expect to get something out of it; on the other hand, they should also be willing or should consider it their duty to add something to the fund of information which our meetings are intended to bring out. By original papers, by presenting topics for discussion, by discussing papers and topics presented by others and by working on committees, members should fulfill their obligation to the Society and promote its welfare.

I feel that it is wise at this review meeting to consider whether or not we as individual members are doing all we should to advance the welfare and prestige of this Society. The professional standard of our meetings is measured to a great extent by the number and character of the papers presented. Data relating to installations which have proved successful under actual working

conditions, descriptions of original methods for accomplishing certain results in heating and ventilation, records of tests, are all of interest and value.

As to tests, one of our standing committees bears that title, yet owing largely to lack of any appropriation to conduct tests, far less has been accomplished than the several heads of that committee have desired. As our Society becomes more prosperous, it seems to me that money could be well spent in this field.

We should keep clearly in mind the objects set forth in our charter. With these objects in view, backed by enthusiasm on the part of members, a large field of useful effort spreads out before us and our achievements will benefit not only our members but the public at large.

To the latter, I feel, we owe a duty. The general acceptance of standards as to minimum heating requirements, the rating of heating boilers and the compulsory ventilation of buildings—these and other kindred subjects are of great importance to the public, affording some protection against disappointment and loss from defective or deficient systems of heating and ventilation.

It is of interest to note that one of the objects set forth in our charter is "To establish a clearly defined minimum standard of heating and ventilating for all classes of buildings." Our constitution makes no mention of this object. In considering the adoption by this Society of any standard, it is worthy of note that the constitution of one of the larger and older engineering societies states: "The Society shall not approve or adopt any standard." In that society professional committees may be appointed and "Reports of such committees may be accepted by the Society and printed in the Transactions, but shall not be approved or adopted as the action of the Society." I am not aware that our Society has ever adopted any standards. Before doing so I would recommend that the subject in general receive careful consideration.

A number of resignations have taken place during the year, but many new members have been admitted, so that a net gain in membership of approximately five per cent. has been recorded.

The growth in membership of this Society must be a source of gratification to those having its interests at heart, yet we must bear in mind that it is not so much the numerical strength in

membership as the strength of its members individually that counts in the long run in the usefulness of the Society to itself and to the public at large.

There are many subjects pertaining to our profession to be investigated, many questions to be solved, much work to be done. If these matters be undertaken with an unselfish spirit, with a desire to add to the general fund of knowledge, we shall see results which will redound to the credit of this Society, and which will elevate the profession of Heating and Ventilating Engineering.

The Secretary's report was read by Secretary Mackay and on motion was ordered received and placed on file.

SECRETARY'S REPORT.

Your Secretary would report an increase in membership during the past year. At the last annual meeting our membership was composed of two honorary members, 302 members, 26 associates and 17 juniors, or a total of 347 members of all grades. During the year we have elected 43 members, seven associates and four juniors. During the year 17 members and 2 juniors were dropped from the roll for non-payment of dues, 1 member and 3 associates failed to qualify, 4 juniors were advanced to full membership, 2 associates were elected to full membership, 4 members and 1 associate resigned, and we had two deaths in our ranks: Mr. T. J. Waters, a charter member of our Society, who died February 25, 1909, and Mr. Max J. Mulhall, who was elected to membership June 25, 1909, and died July 30, 1909. Our present membership is 2 honorary members, 323 members, 27 associates and 15 juniors, or a total of 367 members of all grades, a net increase of 20.

The financial affairs of the Society are in a good condition. At the last annual meeting there was a balance in the treasury of $1,947.95; there has been received from all sources during the year $3,952.14, this, with the balance on hand, making a total of $5,900.09. The total expenditures for the year amounted to $4,687.41, leaving a balance in the treasury of $1,212.68.

There is owing to the Society from members for dues and

proceedings and from newly elected members for initiation fees and dues $1,469.85; this, with the balance on hand, amounts to $2,682.53. All bills have been paid except those in connection with this meeting and the Secretary's account for January. The members dropped from the roll during the past year for non-payment of dues owed the Society $445.00.

One candidate for membership and three for associate membership who were elected during the year failed to qualify. The cost to the Society per candidate for printing, postage, etc., is about $3.00, and your secretary would suggest that a fee of $5.00 be required with each application, to be applied to the initiation fee if applicant is elected, or returned to him if not, as we have a certain number on each ballot who fail to qualify.

The ballot for the proposed amendment to the constitution cost the society over $30.00 for printing, envelopes, addressing and postage.

The Secretary's expenses for the year, including stenographer, clerk hire, post-office box, certificates of membership, expenses in connection with the summer meeting, postage, express, telegrams, telephones, office rent, etc., amounted to $1,204.45.

The 1909 directory was delayed, first on account of some of the members on the May ballot failing to qualify, and second, on account of some of the members neglecting to send in their corrected slips, the Secretary having to furnish 125 addresses and occupations after waiting six weeks, but the directory has finally been completed and mailed to the members.

The papers and reports for this and the summer meeting were received late, putting the Society to an additional expense for night work in connection with printing them, but they were completed and sent to the members as far in advance of the meetings as possible, while any errors were caused by lack of time to read proofs.

The Secretary has a number of applications for membership on hand, which will ensure a ballot being sent out as soon after this meeting as possible.

The Treasurer's report was read by Secretary Mackay in the absence of the Treasurer, and on motion the report was ordered received and placed on file.

TREASURER'S REPORT.

NEW YORK, January 18, 1910.

Balance on hand, January 19, 1909		$1,947.95
Cash received:		
Dues	$3,043.98	
Initiation fees	575.00	
Electrotypes	112.13	
Proceedings	80.00	
Reprinting paper	63.20	
Pin badges	44.00	
Interest on deposits	33.83—	$3,952.14
		$5,900.09
Disbursements:		
J. J. Little & Ives Co., printing 1907 Proceedings	$1,204.80	
J. J. Little & Ives Co., Adv. papers and reprint	259.60	
Schoen & Kellerman, printing and stationery	271.26	
Williams Engraving Co., cuts and electrotypes	319.70	
W. M. Mackay, Secretary's account, December, 1908	98.85	
W. M. Mackay, Secretary's account, December, 1909	1,204.45	
W. M. Mackay, bookcases and shelves.	40.00	
W. M. Mackay, cut cabinet	22.05	
W. M. Mackay, Secretary's salary	600.00	
Harold Godfrey, reporting 1909 annual meeting	110.00	
Arthur W. Kelly, reporting summer meeting	125.00	
Frick Jewelry Co., pin badges	48.00	
J. H. Kinealy, Committee on Standards	50.00	
Carried forward	$4,353.71	

Brought forward		$4,353.71
Illinois Chapter, floral tribute (T. J. Waters)	20.00	
Ehrman Mfg. Co., number buttons	17.83	
United Engineering Society, meeting room	85.00	
William Kent, editing 1908 Proceedings	125.00	
W. W. Macon, re-editing Vol. I.	35.00	
David Williams Co., electrotypes	8.00	
Isidor Kahn, insurance	14.58	
Wm. G. Snow, expenses for year	8.50	
U. G. Scollay, Treasurer's account, 1908	5.70	
Empire Surety Co., Treasurer's bond	6.00	
J. D. Hoffman, expenses Committee on Tests	5.75	
People's Trust Co., exchange	2.34	—$4,687.41
Balance on hand		$1,212.68

Respectfully submitted,
U. G. SCOLLAY, Treasurer.

The President announced that the Board of Governors had appointed Mr. McCann, Mr. May and Mr. Weinshank to act as auditors of the Treasurer's accounts.

The report of the Board of Governors was read by Mr. James Mackay.

REPORT OF THE BOARD OF GOVERNORS.

Your Board of Governors met and organized on January 21, 1909, appointing committees on finance, membership and publication, and an executive committee. The various committees have given careful attention to their duties, and the Board has met seven times during the year, members coming from Boston, Mass., Chicago, Ill., Ann Arbor, Mich., and Ithaca, N. Y., without expense to the Society, to attend the meetings. In addition to this, the individual members of the Board have

called at the office of the Secretary, when in the city, and in this way and by correspondence have kept in touch with the affairs of the Society at all times during the year.

Volume I of the Proceedings of the Society has been carefully re-edited, indexed and printed in an edition of 175 copies, at an expense of $458.00, the original cuts being used. The Board has purchased a bookcase, book shelves and a cut cabinet, for use in the Secretary's office, at a cost of $62.05.

A summer meeting was held at Indianapolis, Ind., on July 15 and 16, 1909, which was largely attended and successful in every way.

Feeling that the Society had received no benefit from membership in the National Fire Protection Association, the Board decided to withdraw from the same.

The Board arranged for a meeting of the committee on boiler surfaces and the committee on standards at Niagara Falls, June 14 to 17, 1909, so that they could confer with the committee of the Manufacturers' and Steam Fitters' Associations, which were meeting there at that time.

The Board increased the discount on the Proceedings to the booksellers, with the understanding that they were not to be sold at less than the regular price.

Applications for a change in the constitution regarding the acceptance and publication of papers and the duties of the publication committee of the Board of Governors were received and were sent to the members for a vote, together with a letter from the officers of the Society to the effect that in their opinion the change, as suggested, was unnecessary and would be detrimental to the best interests of the Society. The number of votes cast was 153; 46 being in favor of and 107 against the amendment, which was lost, 102 votes being necessary for its adoption.

The Board advanced four junior members to full membership.

The Board joined with the Illinois Chapter in sending a suitable floral tribute to the funeral of T. J. Waters, of Chicago, and engrossed resolutions bearing the signature of the President and Secretary and expressing the sympathy of the Society were sent to his widow.

Mr. John Gormly, a past president of the Society, having re-

tired from active business, tendered his resignation to the Society. Action on it was deferred, and your Board would unanimously recommend to the Society that he be elected to honorary membership in the Society at this meeting.

The surplus copies of the Proceedings, 1,257 volumes, which have been stored in the Secretary's office for the past twelve years, have been packed and placed in fireproof storage, and an insurance policy for $1,000 placed on the Society's property in the Secretary's office. This consists of a Remington machine and desk, bookcase, book shelves, two cut cabinets containing the Society's cuts used in the first 13 volumes of the Proceedings, Society's stationery; 15 volumes Mechanical Engineers' Transactions; 18 volumes Electrical Engineers' Transactions; 14 volumes Civil Engineers' Transactions (not bound); 12 volumes Brooklyn Engineers' Club Transactions; 36 monthly issues "Engineering Magazine"; 72 monthly issues "Insurance Engineering"; 30 issues American Institute of Architects Proceedings; 48 issues Western Engineers' Society Proceedings; 30 issues Engineers' Club of Philadelphia Proceedings, and a number of pamphlets, all available to the members and forming the nucleus of a library; 218 volumes Society Proceedings, Vol. 12 to 13; blank certificates of membership; copper plates of certificate and letter head; two solid gold pin badge Society emblems; 20 gold-plated pin badge Society emblems.

The Membership Committee and Board of Governors passed on 43 applications for membership, 7 applications for associates, 4 applications for juniors, all of whom were elected, some failing to qualify.

The Society voted that two committee reports and a paper read from manuscript at the last annual meeting be printed and distributed. As customary in such cases, these reports and the paper were referred to the Publication Committee, which gave careful consideration to the matter and reached the conclusion that it would not be to the best interests of the Society to print these in the form presented, but that they should be edited and published in the Proceedings. A committee report, received at the summer meeting which the Society voted to have printed, was returned to the chairman at his request.

The papers for the summer and annual meetings were re-

ceived late, but all were passed on, printed and distributed to the members as early before the meetings as was possible.

The Society directory was delayed on account of some of the members on the June ballot failing to qualify as expected and from many members failing to furnish their corrections, but it has recently been issued and mailed to the members.

The 1908 volume of the Society Proceedings has been edited, the printed proofs passed on, new cuts prepared for some that were donated, but were a wrong size or imperfectly lettered, and it will be sent to the members as soon after this meeting as possible; while the 1909 volume is well in hand and will be published as early this year as possible.

The meetings of the Board, when held in New York, have been held in the evening to suit the convenience of the members at the New Grand Hotel through the courtesy of Mr. George F. Hurlbert.

While we have lost more members during the past year through suspensions, resignations and deaths, our membership is larger than ever before, with indications of a large increase during the coming year, while the financial affairs of the Society are in a prosperous condition.

(Signed) WILLIAM G. SNOW, Chairman,
AUGUST KEHM, Vice-Chairman,
B. S. HARRISON,
R. C. CARPENTER,
JAMES MACKAY,
B. F. STANGLAND,
JOHN R. ALLEN,
SAMUEL R. LEWIS,
W. M. MACKAY, Secretary.

Mr. Quay moved the adoption of the recommendation of the Board of Governors that Mr. John Gormly be elected to honorary membership in the Society. The motion was carried unanimously by a standing vote.

Mr. Quay: It seems by the committee's report that they had a communication from the American Society of Mechanical Engineers suggesting some affiliation between the two societies, and I understand the Board of Governors had made no recom-

mendation. I would like to know what their opinion is in regard to this question, or whether the Society should take some action on the question or not.

The President: I will answer that from the chair, that no opinion was arrived at, and we have been investigating the relations between the larger society and some of the small ones, but have not been prepared to make any recommendation to this Society. It is a matter that the incoming Board of Governors can continue to investigate and make a recommendation if they see fit. We did not reach a point where we wished to make any definite recommendation to the Society.

On motion the report of the Board of Governors was received and ordered to be placed on file.

President Snow: We have a report from the Committee on Compulsory Legislation which, in the absence of the Chairman, Mr. Hale, will be read by Mr. Davis.

The report was read by Mr. Davis.

REPORT OF THE COMMITTEE ON COMPULSORY LEGISLATION.

Mr. President:

Your Committee on Compulsory Legislation has, during the past year, endeavored to have bills introduced and laws passed in several States relating to the ventilation of public buildings, but on account of a combination of circumstances have not been able to accomplish a great deal.

In the State of Indiana a bill was introduced and not only passed in Senate, but had reached the third reading in the House, when it was killed because the father of the bill was in disfavor. Later on the State Board of Health was given power to act in the matter of ventilation of schools, but we are hopeful that some law will be put through during the next Legislature in 1911.

An attempt was made to introduce a bill before the Wisconsin State Legislature, but for some reason, which your committee could not learn, it was never brought up for even the first reading. We are told, however, that another attempt will be made to bring the subject up again in 1911, when the next Legislature convenes.

In Illinois we were no more successful than in Wisconsin, the principal reason being the Senatorial fight which lasted through almost the entire session. The local State committee report that they are hopeful of such a bill being passed in 1911.

We are pleased to report that a law was passed during the year 1909 in the State of Illinois, the same being,

"AN ACT to provide for the health, safety and comfort of employees in factories, mercantile establishments, mills and workshops in this State, and to provide for the enforcement thereof."

Extracts from this bill—which became a law on January 1, 1910—are as follows:

"SECTION 11. In every factory, mercantile establishment, mill or workshop, where one or more persons are employed, adequate measures shall be taken for securing and maintaining a reasonable, and as far as possible, equable temperature, consistent with the reasonable requirements of the manufacturing process. No unnecessary humidity which would jeopardize the health of employees shall be permitted."

"SECTION 12. In every room or apartment of any factory, mercantile establishment, mill or workshop, where one or more persons are employed, at least 500 cubic feet of air space shall be provided for each and every person employed therein, and fresh air to the amount specified in this act shall be supplied in such a manner as not to create injurious drafts, nor cause the temperature of any such room or apartment to fall materially below the average temperature maintained: Provided where lights are used which do not consume oxygen, 250 cubic feet of air space shall be deemed sufficient. All rooms or apartments of any factory, mercantile establishment, mill or workshop, having at least 2,000 cubic feet of air space for each and every person employed in each room or apartment, and having outside windows and doors whose area is at least (one-eighth) of the total floor area, shall not be required to have artificial means of ventilation; but all such rooms or apartments shall be thoroughly aired before beginning work for the day and during the meal hours. All such rooms, or apartments, having less than 2,000 cubic feet of air space, but more than 500 cubic feet of air space, for each and every person employed therein, and which

have outside windows, and doors whose area is at least one-eighth of the floor area, shall be provided with artificial means of ventilation, which shall be in operation when the outside temperature requires the windows to be kept closed, and which shall supply during each working hour at least 1,500 cubic feet of fresh air for each and every person employed therein. All such rooms or apartments, having less than 500 cubic feet of air space for each and every person employed therein, all rooms or apartments having no outside windows or doors, and all rooms or apartments having less than 2,000 cubic feet of air space for each and every person employed therein, and in which the outside window and door area is less than one-eighth of the floor area, shall be provided with artificial means of ventilation, which will supply during each working hour throughout the year, at least 1,800 cubic feet of fresh air for each and every person employed therein: Provided, that the provisions of the preceding portions of this section shall not apply to storage rooms or vaults: And, provided, further, that the preceding portions of this section shall not apply to those rooms or apartments in which manufacturing processes are carried on which from their peculiar nature would be materially interfered with by the provisions of this section. No part of the fresh air supply required by this section shall be taken from any cellar or basement."

"The following terms of this section shall be interpreted to mean: The air space available for each person is the total interior volume of a room, expressed in cubic feet, without any deductions for machinery contained therein, divided by the average number of persons employed therein."

"Outside windows and doors are those connecting directly with the outside air; the window and door area is the total area of the windows and doors of all outside openings; and the floor area is the total floor area of each room."

"SECTION 29. The provisions of this Act relating to sanitation and ventilation shall not be held to apply to such rooms or apartments of any factory, mercantile establishment, mill or workshop, which are being operated under the supervision of the federal government, by virtue of an Act of Congress, entitled 'An Act making appropriations for the Department of

Agriculture for the fiscal year ending June thirtieth, nineteen hundred and seven,' approved June 30, 1906, or any amendment thereof; nor shall any other of the provisions of this Act so apply respecting matters and conditions over which the federal government now exercises or shall hereafter exercise jurisdiction."

Your attention is also called to the fact that the law provides that "anyone who shall violate any of the provisions of this Act shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished for the first offense by a fine of not less than $10.00 and not more than $50.00, and upon the conviction of the second or subsequent offense shall be fined not less than $25.00 and not more than $200.00, and in each case shall stand committed until such fines or costs are paid, unless otherwise discharged by due process of law."

A bill prepared by a member of your committee was presented at the last Michigan State Legislature, but it came up so late that other matters before the House prevented any action being taken. When the Legislature meets again, it should be the object of the Committee on Compulsory Legislation to see that this bill is brought before the House early enough, so that it will be taken up in order and at a time when the Legislature will have an opportunity to give it the consideration it deserves. In fact, what has just been said should apply to all bills which are still pending in the several States.

We are pleased to state that under date of September 20, 1909, the State Board of Health of Vermont promulgated regulations covering, among other things, the heating and ventilation of school-houses, hospitals and other public buildings. They are as follows:

"(A) The heating apparatus must be of sufficient capacity to warm all rooms to 70 degrees Fahrenheit in any weather.

"(B) With the rooms at 70 degrees, and a difference of not less than 40 degrees between the temperature of the outside air and that of the air entering the room at the warm air inlet, the apparatus must supply at least 30 cu. ft. of air per minute for each person accommodated in the rooms.

"(C) Such supply of air should so circulate in the rooms that no uncomfortable draft will be felt, and that the difference

in temperature between any two points on the breathing plane in the occupied portion of the room will not exceed 3 degrees.

"(D) Vitiated air in amount equal to the supply from the inlets should be removed through the vent ducts.

"(E) The closets and fixtures must be so arranged and ventilated that no odors therefrom shall be perceived in any portion of the building."

"To secure the approval of the State or local health officials of plans showing methods or systems of heating and ventilation, the aforementioned requirements must be guaranteed in the specifications accompanying the plans. In school-houses, hospitals and other institutions, the number of occupants intended for each room should be given, and in places of assemblage the arrangements of seats and aisles should be shown on plans."

"As 40 pupils are as large a number as one teacher can well instruct, the rooms, it is specified, shall be 32 x 28 x 12 ft. high, giving from 200 to 300 cu. ft. of air space and 20 sq. ft. of surface area for each pupil."

"The windows must be numerous, large enough, and so arranged as to give ample light to every part (and corner) of the room. The window space should be one-fourth of the floor space, and must be not less than one-fifth. There must be no more space between the top of the window and the ceiling than is required to finish the building, and the window-sill must be 4 ft. from the floor."

The compulsory character of the regulations is indicated from the following extracts from the public statutes of Vermont:

DEFINITION OF PUBLIC BUILDINGS

"SECTION 5412. The words 'public buildings,' as used in this chapter, shall mean churches, school buildings, hotels more than two stories high and places of amusement more than one story high, and buildings, factories, mills or workshops more than two stories high in which persons are employed above the second story."

"SECTION 5416. Said board shall, when necessary, issue to local boards of health its regulations as to the lighting, heating and ventilation of school-houses, and shall cause sanitary inspection to be made of churches, school-houses and places of public

resort, and make such regulations for the safety of persons attending the same as said board deems necessary. Public buildings now standing or hereafter erected shall conform to the regulations of said board in respect to sanitary conditions and fire escapes necessary for the public health and for the safety of individuals in such public buildings."

"A person, corporation or committee intending to erect a public building shall submit plans thereof showing the method of heating, plumbing, ventilation and sanitary arrangements to said board, and procure its approval thereof before erecting such building."

PENALTY FOR FAILURE TO VENTILATE

"SECTION 5417. A person, corporation or committee which erects a public building without the approval and without complying with the regulations of the State Board of Health, as provided for in the preceding section, shall be fined not more than $500.00 nor less than $100.00, and shall make such building to conform to the regulations of said board before the same is used, otherwise such building shall be deemed a nuisance, and shall be put in proper condition by the local health officer under direction of said board at the expense of the owner."

SANITARY ADMINISTRATION OF SCHOOL-HOUSES

The regulations, in addition to architectural features, include the following partial list:

"1. Dusting with damp cloth. Sweeping with damp broom.

"2. Slates, slate pencils and sponges should not be used in the school-room. In place of these, each pupil, according to requirements, should be supplied with paper, pencil or pen and penholder. These should be kept in a box marked with the pupil's name, and never transferred from one pupil to another.

"3. Each pupil should be provided with a drinking cup marked with the pupil's name, and this kept on a hook or nail over the pail or faucet."

"4. School-rooms should be swept and dusted after school hours. No dust should be stirred up before school in the morning. Teachers should know that dust and germ life are identical."

Your committee understands that a special report is to be made by one of its members relative to the work done by previous committees on Compulsory Legislation, and these two statements taken together should be considered as a complete report on the subject.

Respectfully submitted,

COMMITTEE ON COMPULSORY LEGISLATION,
JOHN F. HALE, Chairman;
GEORGE MEHRING, BERT C. DAVIS,
H. D. CRANE, FRED R. STILL.

January 15, 1910.

APPENDIX.

MASSACHUSETTS VENTILATION LAW.

In an Act entitled "Of the Inspection of Buildings" (Acts of 1902), Chapter 104, Revised Laws of Massachusetts, Sections 22, 23 and 24, and Chapter 106, Revised Laws of Massachusetts, Sanitary Provisions, Sections 54 and 55, will be found the following:

"SECTION 22. No building which is designed to be used, in whole or in part, as a public building, public or private institution, school-house, church, theatre, public hall, place of assemblage, or place of public resort, and no building more than two stories in height, which is designed to be used above the second story, in whole or in part, as a factory, workshop, mercantile or other establishment, and has accommodations for ten or more employees above said story, and no building more than two stories in height, designed to be used above the second story, in whole or in part, as a hotel, family hotel, apartment house, boarding house, lodging house, or tenement house and has ten (10) or more rooms above said story, shall be erected until the plans thereof have been deposited with the inspector of factories and public buildings, for the district in which it is to be erected, by the person causing its erection, or by the architect thereof. Such plans shall include the method of ventilation provided therefor, and a copy of such portion of the specifications therefor as the inspector may require."

"SECTION 23. No wooden flue or air duct for heating or ventilating purposes shall be placed in any building which is subject to the provisions of Sections 24 and 25 (the sections refer to buildings such as those already described, coming under the inspection of the fire inspectors), and no pipe for conveying hot air or steam in such building shall be placed or remain within 1 inch of any woodwork unless protected to the satisfaction of said inspector by suitable guards or casings of incombustible material."

"SECTION 24. Whoever erects or constructs a building, or architect or other person who draws plans or specifications, or superintends the erection of a building in violation of the provisions of this chapter, shall be punished by a fine of not less than $50.00 or more than $1,000.00." Chapter 106, Revised Laws of Massachusetts, Sanitary Provisions.

"SECTION 54. Every public building and every school-house shall be kept clean and free from effluvia arising from any drain, privy or nuisance, shall be provided with a sufficient number of water closets, earth closets or privies, and shall be ventilated in such a manner that the air shall not become so impure as to be injurious to health. The provisions of this section shall be enforced by the inspection department of the district police."

"SECTION 55. If it appears to an inspector of factories and public buildings that further or different sanitary or ventilating provisions, which can be provided without unreasonable expense, are required in any public building or school-house, he may issue a written order to the proper person or authority, directing such sanitary or ventilating provisions to be provided."

"A school committee, public officer, or person who has charge of, owns or leases any such public building or school-house, who neglects for four weeks to comply with the order of such inspector, shall be punished by a fine of not more than $100.00."

"Whoever is aggrieved by the order of an inspector issued as above provided, and relating to a public building or school-house, may, within thirty days after the service thereof, apply in writing to the board of health of the city or town, to set aside or amend the order; and thereupon the board, after no-

tice to all parties interested, shall give a hearing upon such order, and may alter, annul or affirm it."

Acting under the authority of this act, the district police caused the following order to be issued, which is best known among heating and ventilating engineers as "Form No. 83."

REQUIREMENTS OF "FORM NO. 83," INSPECTION DEPARTMENT, MASSACHUSETTS DISTRICT POLICE.

"In the ventilation of school buildings the many hundred examinations made by the inspectors of this department have shown that the following requirements can easily be complied with":

"1. That the apparatus will, with proper management, heat all rooms including the corridors to 70 degrees F. in any weather."

"2. That, with the rooms at 70 degrees and a difference of not less than 40 degrees between the temperature of the outside air and that of the air entering the room at the warm air inlet, the apparatus will supply at least 30 cubic feet of air per minute for each scholar accommodated in the room."

"3. That such supply of air will so circulate in the rooms that no uncomfortable draft will be felt, and that the difference in temperature between any two points on the breathing plane in the occupied portion of the room will not exceed 3 degrees."

"4. That vitiated air in amount equal to the supply from the inlets will be removed through the vent ducts."

"5. That the sanitary appliances will be so ventilated that no odors therefrom will be perceived in any portion of the building."

"To secure the approval of this department of plans showing methods of systems of heating and ventilating, the above requirements must be guaranteed in the specifications accompanying the plans."

MINNESOTA STATE BOARD OF HEALTH.

Regulations Relating to Construction of School Buildings.

"146. No school-room, or class-room, except an assembly-room, shall have a seating capacity that will provide less than

eighteen square feet of floor space and 216 cubic feet of air space per pupil, and no ceiling in a building hereafter to be erected shall be less than 12 feet from the floor."

"147. A system of ventilation, in order to be approved by the Minnesota State Board of Health, shall furnish not less than thirty cubic feet of air per minute for each person that the room will accommodate, when the difference of the temperature between the outside air and the air in the school-room shall be 30 degrees F. or more."

"148. In a gravity system of ventilation in connection with a furnace or steam plant the flues for admitting fresh air to the room, as well as the vent flues, shall have a horizontal area of not less than one square foot for every nine persons that the room will accommodate."

"149. The flues for a 'plenum' or 'vacuum' system of ventilation shall have a horizontal area of not less than one square foot for every fifteen persons that the room will accommodate."

"150. The window space shall equal one-fifth of the floor space of the school-room."

"151. In all rooms not exceeding twenty-five feet in width all the light shall be admitted to the left of the pupils."

"152. In rooms exceeding twenty-five feet in width, light shall be admitted to the left and rear of the pupils."

"153. Translucent instead of opaque shades shall be used in the windows for controlling the light."

"154. The top of the windows shall be as near the ceiling as the mechanical construction of the building will allow.

"155. No cloak-room shall be less than six feet wide, nor shall it have less than one window."

"156. The so-called 'sanitary wardrobe' which allows the foul air of the room to pass through the clothing of the children before passing into the vent duct, shall be condemned as unsanitary."

NEW JERSEY'S VENTILATION LAW.

Under the heading of "New Jersey's School Laws, Revision of 1903," is a section regulating the ventilation of school-houses. The act is known as the Stokes Law, having been introduced by

Governor Stokes of New Jersey, at the time when he was a member of the Legislature.

The ventilation requirements appear under Article X, Section 131, the first three paragraphs of which read as follows:

"1. Light shall be admitted from the left or from the left and rear of class-rooms, and the total light area must, unless strengthened by the use of reflecting lenses, be equal to at least 20 per cent. of the floor space."

"2. School-houses shall have in each class-room at least 12 square feet of floor space and not less than 200 cubic feet of air space per pupil. All school buildings shall have an approved system of ventilation by means of which each class-room shall be supplied with fresh air at the rate of 30 cubic feet per minute for each pupil."

"3. All ceilings shall be at least 12 feet in height."

NEW YORK STATE VENTILATION LAW.

An Act of 1904 by the New York State Legislature relating to ventilation of school-houses contains the following:

"An Act to amend the consolidated school law, relative to proper sanitation, ventilation and protection from fire of school-houses."

"1. No school-house shall hereafter be erected in any city of the third class or in any incorporated village or school district of this State, and no addition to any school building in any such place shall hereafter be erected, the cost of which shall exceed five hundred dollars, until the plans and specifications for the same shall have been submitted to the Commissioner of Education and his approval endorsed thereon. Such plans and specifications shall show in detail the ventilation, heating and lighting of such buildings. Such Commissioner of Education shall not approve any plans for the erection of any school building or addition thereto unless the same shall provide at least fifteen square feet of floor space and two hundred cubic feet of air space for each pupil to be accommodated in each study or recitation-room therein, and no such plans shall be approved by him unless provision is made therein for assuring at least thirty cubic feet of pure air every minute per pupil, and the facilities for exhausting the foul or vitiated air therein shall be positive and in-

dependent of atmospheric changes. No tax voted by a district meeting or other competent authority in any such city, village or school district, exceeding the sum of five hundred dollars shall be levied by the trustees until the Commissioner of Education shall certify that the plans and specifications for the same comply with the provisions of this act. All school-houses for which plans and detailed statements shall be filed and approved, as required by this act, shall have all halls, doors, stairways, seats, passages, and aisles and all lighting and heating appliances and apparatus arranged to facilitate egress in cases of fire or accident, and to afford the requisite and proper accommodations for public protection in such cases. All exits shall open outwardly and shall, if double doors be used, fasten with movable bolts operated simultaneously by one handle from the inner face of the door. No staircase shall be constructed with wider steps in lieu of a platform, but shall be platforms. No doors shall open immediately upon a flight of stairs, but a landing at least the width of the door shall be provided between such stairs and such doorway.

"2. This act shall take effect immediately."

NEW YORK STATE FACTORY VENTILATION LAW.

The following factory ventilation law was adopted in its present form in October, 1907. The law appears under "Article VI.—Factories," and is numbered Section 86:

"The owner, agent or lessee of a factory shall provide, in each work-room thereof, proper and sufficient means of ventilation; and shall maintain proper and sufficient ventilation; if excessive heat be created or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the room must be ventilated in such a manner as to render them harmless, so far as is practicable; in case of failure the Commissioner of Labor shall order such ventilation to be provided."

"Such owner, agent or lessee shall provide such ventilation within twenty days after the service upon him of such order, and in case of failure, shall forfeit to the people of the State, $10.00 for each day after the expiration of such twenty days,

to be recovered by the Commissioner of Labor." (As amended by L. 1907, ch. 400, in force Oct. 1.)

PENNSYLVANIA VENTILATION LAW.

A law enacted in 1905 in the State of Pennsylvania and signed by Governor Pennypacker on April 22, 1905, relative to the ventilation of school buildings, contains the following:

" Entitled, An Act for the purpose of governing the construction of public school buildings in order that the health, sight and comfort of all pupils may be protected."

" Whereas, it is of great importance to the people of this Commonwealth that public school buildings hereafter erected by any board of education, school trustee or school directors shall be properly heated, lighted and ventilated.

" SECTION 1. Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania, in General Assembly met, and it is hereby enacted by the authority of the same, that, in order that due care may be exercised in the heating, lighting and ventilating of public school buildings, hereafter erected, no school-house shall be erected by any board of education or school district in this State, the cost of which shall exceed four thousand ($4,000.00) dollars, until the plans and specifications for the same shall show in detail the proper heating, lighting and ventilating of such building."

" SECTION 2. Light shall be admitted from the left or from the left and rear of class-rooms, and the total light area must, unless strengthened by the use of reflecting lenses, equal at least twenty-five per centum of the floor space."

" SECTION 3. School-houses shall have in each class-room at least fifteen square feet of floor space and not less than two hundred cubic feet of air space per pupil, and shall provide for an approved system of heating and ventilation by means of which each class-room shall be supplied with fresh air at the rate of not less than thirty cubic feet per minute for each pupil and warmed to maintain an average temperature of 70 degrees F. during the coldest weather."

" SECTION 4. All acts or parts of acts inconsistent herewith are hereby repealed."

UTAH STATE VENTILATION LAW.

An Act of 1907 by the Utah State Legislature, and which went into effect in 1909, contains the following in Chapter 32, Section 1823:

"SECTION 1. That Section 1823, Compiled Laws of Utah, 1907, be, and the same is amended to read as follows:"

"1823. *Plans of New Buildings to be Submitted to Commission.* When necessary for the welfare of the schools of the district, or to provide proper school privileges for the children therein, or whenever petitioned so to do by one-fourth of the resident taxpayers of the district, the board shall call a meeting of the qualified voters, as defined in section eighteen hundred and eleven, at some convenient time and place fixed by the board, to vote upon the question of selection, purchase, exchange, or sale of a school-house, or for payment of teachers' salaries, or for current expenses of maintaining schools. The Chairman of the Board shall be Chairman, and the Clerk of the Board Secretary to such meeting."

"In case either of these officers is not present, his place shall be filled by some one chosen by the voters present. Notice, stating the time, place and purpose of such meeting, shall be posted in three public places in the district by the Clerk of the District Board at least twenty days prior to such meeting. If a majority of such voters present at such meeting shall by vote select a school-house site, or shall be in favor of the purchase, exchange, or sale of a designated school-house site, or of the erection, removal, or sale of a school-house, as the case may be, the Board shall locate, purchase, exchange or sell such site, or erect, remove or sell such school-house, as the case may be, in accordance with such vote; provided, that it shall require a two-thirds vote to order the removal of a school-house."

"Provided that no school-house shall hereafter be erected in any school district of this State not included in cities of the first and second class, and no addition to a school building in any such place the cost of which school-house or addition thereto shall exceed $1,000.00 shall hereafter be erected until the plans and specifications for the same shall have been submitted to a commission consisting of the State Superintendent of Public

Instruction, the Secretary of the State Board of Health, and an architect to be appointed by the Governor, and their approval endorsed thereon. Such plans and specifications shall show in detail the ventilation, heating and lighting of such buildings. The commission herein provided shall not approve any plans for the erection of any school building or addition thereto unless the same shall provide at least fifteen square feet of floor space and two hundred cubic feet of air space for each pupil to be accommodated in each study or recitation room therein, and no such plans shall be approved by them unless provision is made therein for assuring at least thirty feet of pure air per minute for each pupil and the facilities for exhausting the foul or vitiated air therein shall be positive and independent of atmospheric changes. No tax voted by a district meeting or other competent authority in any such school district shall be levied by the trustees until the commission shall certify that the plans and specifications for the same comply with the provisions of this act. All school-houses for which plans and detailed statements shall be filed and approved, as required by this Act, shall have all halls, doors, stairways, seats, passageways, and aisles, all lighting and heating appliances and apparatus arranged to facilitate egress in cases of fire or accident and to afford the requisite and proper accommodations for public protection in such cases."

"No school-house shall hereafter be built with the furnace or heating apparatus in the basement or immediately under such building."

VIRGINIA VENTILATION LAW.

"An Act for the purpose of regulating the construction of public school buildings in order that the health, sight and comfort of all pupils may be properly protected."

Approved March 11, 1908.

"Whereas, it is of great importance to the people of this Commonwealth that public school buildings hereafter erected by any school board shall be properly heated, lighted and ventilated; therefore,"

"1. Be it enacted by the General Assembly of Virginia, that

the State Board of Inspectors for Public School Buildings shall not approve any plans for the erection of any school building or room in addition thereto unless the same shall provide at least fifteen square feet of floor space and two hundred cubic feet of air space for each pupil to be accommodated in each study or recitation room therein, and no such plans shall be approved by said board unless provision is made therein for assuring at least thirty cubic feet of pure air every minute per pupil, and the facilities for exhausting the foul and vitiated air therein shall be positive and independent of atmospheric changes. All ceilings shall be at least twelve feet in height."

Extract from Amendments and New Laws of the General Assembly of 1898.

DISCUSSION.

Mr. James Mackay: This Society never before received a report as complete and full as the one just read. It indicates that the committee has done hard, conscientious work in a difficult field. They should be encouraged and thanked. The matter of ventilation through compulsory legislation is one of the most important duties in charge of standing committees.

To promote this work the Illinois Chapter appointed Mr. Mehring, Mr. Lewis and myself as a committee for the State of Illinois. We were successful in having a reasonably good compulsory ventilation bill introduced and passed by the Illinois House of Representatives, but it was killed in the Senate.

Mr. Barron: There is one other question in compulsory legislation, and I want to give my individual voice to the splendid work that the committee has done, and also move a vote of thanks. What I want to say now is this: that it is evidence of an improvement in the character of the Society in recent years, that the Society has greater moral force than it had previously. Of course that is natural with its growing strength and all that sort of thing, but outside of that the organization of the Illinois Chapter has brought the work to a head that it never was brought to before.

I have a recommendation to make: that an Atlantic Coast Chapter be formed, also that an Alleghany Mountain Chapter

be formed, that the Illinois Chapter be increased to the Interior States Chapter, that a Rocky Mountain Chapter be formed and also that a Pacific Coast Chapter be formed. Now that would, I believe, strengthen the Society, and I am sure the members can double the membership of the Society at once by such an effort. Of course I believe the expenditure allowed to make such organizations should not exceed $100, and that can be considered. But the Board of Governors should make an effort to form new chapters, because one body that was organized, the Chicago members, has done such tremendously good work.

Mr. Myrick: On this question of compulsory legislation I don't know how many of the gentlemen present have had any experience in legislative matters; but when you pass a law like the apartment law you are hurting yourself by backing legislation of that kind. Now we are all going to be benefited by these committees, but we have got to be careful and not make a step in the wrong direction. I do not believe in all this agitation and publicity. The danger is in taking any stand. We are very careful not to take any stand on other things, and we had better be careful on this. This is the most dangerous thing of all.

Now mill operators and big employers are fast coming around to the point, and they would have been to this point before if it had not been for this adverse legislation. Say you must put 30 feet of air per minute per person into a building. You can't do it in a cotton mill, while the thread is very sensitive, and in other kinds of manufacture, you cannot put that in and take it out. It is impossible. It would ruin the business.

Now when you make that drastic legislation you are going to get a decision of the Supreme Court that will knock it all in the head if you are not careful. Yet you must have some penalty attached to it—you must have some sensible legislation. Now don't go too far or too fast. Our employers are beginning to realize that they get more efficiency, whether they work by piece-work, by the week or by the day, by having proper conditions, and large corporations are getting around to it, and contribute large sums of money to stamp out this white plague, and lately, by the gradual co-operation of the Red Cross Society, as Secretary Mackay said, they spend a good many thousand dollars in the City of New York.

You also will get a good deal of co-operation from the labor unions, but do not advocate any bill, and put the stamp of approval of the American Society of Heating and Ventilating Engineers unless you are sure what you have got. Be right and then go ahead. And I wish to say furthermore that I think it is the duty of every member here when he sees anything along this line to send it to the Secretary, so it can be distributed according to the opinion of the Board of Governors, so each one of us throughout the United States can be able to get hold of that information and help it along that line.

President Snow: I wish to assure the gentleman who has just spoken that that is the object of this Society, and I am sure that every member appreciates that we do not want to overstep, and I believe that every one of you will work to that end.

Mr. Whitten: We have a Publicity Committee, and that is a special committee consisting of members from the various States. We have a Compulsory Legislation Committee, which is no special committee, but assumes that every member of the Society is a member of that special committee. Now what is everybody's business I have found most of the time is nobody's business. I simply offer a suggestion that this legislative committee have by some means an accredited representative, a member of this Society, in every State, who can assist it, particularly in those cases where assistance is most needed, along the line of our Publicity Committee.

Professor Kent: Mr. Myrick has intimated that something practicable can be done in Indiana, and he proposes to introduce a bill at the summer meeting. I suggest that Mr. Myrick ask Dr. Hurty to prepare a paper for this Society—non-members can present papers—giving his ideas on ventilation as relating to health. I think, in all the work that we have done here before, we took it for granted that ventilation was necessary, but I think that some of the present members of the legislature do not understand it that way. I think we ought to have something in print showing them the reasons why ventilation is necessary. I think Dr. Hurty can prepare such a paper from his knowledge of the subject.

I would like to see that subject taken up acceptably in Dr. Hurty's paper, or such other papers as we may get, and that

we have this in shape before the summer meeting. A printed report of this meeting would make an excellent pamphlet on the subject of ventilation in schools, and something to discuss in our meetings.

Mr. Myrick: The tendency is now all over the United States towards uniformity of laws. You see it in the corporation laws and the marriage and divorce laws. And the point I want to bring out is that I think this Committee on Compulsory Legislation should have some authority to get together and thoroughly consider, with such men as Dr. Hurty and other people, some practical idea of compulsory legislation so it will be uniform in every State, so it will be some sort of uniform law that can be presented to every State Legislature with the stamp of approval of the American Society of Heating and Ventilating Engineers. If you are going to try to get some such thing from one State, as the committee reported, in Illinois, and get something else up here in Vermont that is supposed to have started from Massachusetts, where you have absolutely got nothing definite, you are going to have a peculiar condition. And if we are backing a bill before the Legislatures of the different States that may be poorly drawn with loopholes or unconstitutional clauses therein, you are going to get a little mite of recognition, I fear. So I think before we go too far with this the committee ought to see if they cannot get something that is fair, just and equitable to every State and then go right straight ahead and get behind it every member and push it right through. You will get the members with you, and get everybody else with you; but it means a great deal more than a lot of people realize, and first and foremost it is a benefit to humanity in general.

Mr. Hale: I have something to else to say that I think will be of interest. The Illinois Chapter held a special meeting a week ago, at which Dr. Evans, of Chicago, Dr. Hurty, of Indianapolis, and fortunately, Dr. Winslow, of the Institute of Technology, were all present. We had a number of architects and engineers and contractors, who were all interested in the subject of ventilation; the three speakers of the evening discussed the question of the best method of ventilating a schoolroom; and it seemed that the consensus of opinion was, or rather, from their point of view, that the heating and ventilat-

ing engineers' province was to tell how to accomplish the results that the doctors put down as the basis on which you were to work. They requested the chair at that meeting to appoint a committee of three members of the Illinois Chapter to cooperate with three members or a committee of three appointed by the Chicago Health Commission, to discuss that in committee work and decide if they could what was necessary to ventilate and what the requirements were, and then put it up to the engineers to determine how to do it. And I don't know whether the Society will have any objection to the chapter's committee handling that. Of course they will not do anything until the whole thing is reported to the Society, but I believe, leading up to the suggestion that was made by Mr. Lewis, that after that report is made the committee that he suggests can better be able to frame up a uniform law.

On motion the report was ordered received and transferred to the Secretary for publication in the Proceedings.

The report of the Committee on Compulsory Legislation in New York State was read by Mr. Chew in the absence of the chairman, Mr. Harrison.

REPORT OF COMMITTEE ON LEGISLATION FOR NEW YORK STATE.

Gentlemen: Your Committee has little to report in the way of anything actually accomplished other than the ascertainment of certain facts and conditions.

The facts regarding loft ventilation are about as follows:

The law now in force requires that a certain amount of ventilation be provided, but does not designate just what is necessary to fulfill it. The enforcement of that law and the determination of the actual requirements in each case to fulfill it, rest with one man. It is exceedingly difficult for him alone and unaided to accomplish the desired results.

The individual owner appears to be willing to conform to the requirements, but the large owners—real estate operators and corporations—rather prefer to fight, claiming that a one-man interpretation of a law is not apt to be a lasting one, and that every change in the office would bring a different interpretation.

They even go so far as to insinuate, if not openly charge, bad faith.

It appears that there are many prominent people and bodies of people outside the Society who would be glad to co-operate in a united movement to get such legislation, as would compel proper ventilation, and would definitely state what that ventilation should consist of under different conditions.

It appears that through the Federation of Labor, the unions themselves could be enlisted in the cause to better their own conditions.

This Committee, therefore, recommends that a committee of three men be appointed with power to draft a bill for presentation to the Legislature within one month, and that the Committee shall invite any and all persons and bodies outside the Society to co-operate and lend the weight of their influence to get the bill passed this year.

The bill should designate the necessary degree of ventilation; and requires that the system installed be a ventilation system in fact as well as name. It should prohibit such installation as can be made inoperative as soon as the inspector's back is turned, as well as those wherein the ventilation is attempted by means of untempered air. A cold, drafty ventilation should be prohibited.

BURT S. HARRISON,
FRANK K. CHEW,
W. M. MACKAY.

Mr. Quay: Mr. Chairman, this report is a very important one and the recommendations made are really necessary. I have had a good deal to do with Mr. Walling, the factory inspector, along this line, and he admits, as well as our Committee, that the law is very inefficient. The law requires that two thousand feet of air be furnished for each person in a factory per hour, but it cannot require that that air be heated and cannot require any ducts to give the proper distribution. It simply requires that there be fans or ventilators put in to exhaust that air and some means provided for the air to come in, and he is having a very hard time enforcing the law. A great many owners are fighting it, and it is not very much wonder that

they are, unless the law is changed to make it practical. You all know that to bring cold air on a cold day into a room and to draw out, even the amount specified, is really injurious to life. So I would make a motion that the recommendations of the Committee be adopted, with one exception. I do not like the idea of picking out any certain men, and naming them to act as members of a committee to act on a case of this kind, and I think that the names of these persons that have been mentioned should be eliminated from the report, but otherwise the recommendations that have been made should be adopted by the Society.

The question of omitting certain names from the report was discussed by Messrs. Chew, Quay and Barron.

President Snow: I will state for the information of the meeting that all these names are mentioned in the last paragraph, and that Mr. Quay's motion is in effect that the report of this Committee be accepted, but with the last paragraph stricken out.

The motion was seconded and carried.

President Snow: The report is received, the last paragraph being stricken out.

We have a report from the Committee on Tests, one of the standing committees. Professor Hoffman will please read his report.

REPORT OF THE COMMITTEE ON TESTS

The undersigned membership of your Committee on Tests, appointed soon after the January meeting, 1909, has the following report to make:

A letter was sent out to each member of the Society from the Committee on May 10, 1909, and another on November 3, 1909. Each letter urged the co-operation of the membership of the Society with the efforts of the Committee, looking forward to a very complete report at this review meeting. Some promises were given that material would be forthcoming, but as yet the data have not arrived. The Committee feels that the members of the Society are in sympathy with all efforts to further the Society's interests, but because of business require-

ments they have not had the necessary time to collect such data as they may have, and send it in to the Committee.

TEST OF INDIRECT PIN RADIATORS.

One very valuable set of data on tests of long pin indirect radiation, and short pin indirect radiation was received. This follows as a part of the Committee report.

An endeavor will be made later to add to these data some points relative to the conditions under which the data were collected.

TESTS OF INDIRECT SHORT PIN RADIATORS.

Prof. JOHN R. ALLEN.

Number.	Gauge pressure.	Entering Steam (T_1).	Entering Air Average (T_2 and T_3).	Leaving Air Average (T_4 and T_5).	Room Temperature Average (T_6 and T_7).	Increase in Temperature of Air.	Cu. ft. Air per hr. per sq ft. Surface (rated).	Lbs. Steam per hr. per sq. ft. Surface (rated).	B.T.U.'s per hr. per sq. ft. (rated).	B.T.U.'s per hr. per deg. diff. av. Air and Steam per sq. ft. (rated).	B.T.U.'s per hr. per deg. diff. av. Air and Steam per cu. ft. Air per sq. ft. Surface (rated).
3	4.8	226.3°	39.0°	147.0°	56.0°	108.0°	100.0	.2164	207.4	1.556	.0001556
4	4.7	226.4°	38.7°	146.4°	56.2°	107.7°	111.2	.2400	230.0	1.718	.0001531
5	4.7	226.4°	39.4°	146.9°	56.0°	107.5°	101.9	.2196	210.2	1.578	.0001549
6	4.7	226.3°	39.8°	141.5°	55.8°	101.7°	92.1	.1890	181.1	1.336	.0001446
7	4.8	226.0°	39.0°	146.8°	55.9°	107.8°	191 5	.3948	382.6	2.875	.0001502
8	4.74	225.5°	38.3°	147.7°	55.4°	109.4°	195.3	.4126	395.8	2.988	.0001530
9	4.75	225.4°	39.0°	148.4°	55.1°	109.4°	192.4	.4068	390.7	2.967	.0001542
10	4.8	226.0°	54.0°	155.6°	56.4°	101.6°	160.2	.3242	310.9	2.565	.0001601
11	5.0	226.1°	53.7°	156.5°	55.4°	102.8°	160.4	.3242	311 0	2.570	.0001602
12	14.2	244.1°	38.8°	155.1°	65.3°	116.3°	273.0	.6120	577.5	3.924	.0001437
13	14.4	244.9°	38.6°	156.2°	62.8°	117.6°	271.0	.6160	587.0	3.939	.0001454
14	14.6	245.1°	39.1°	157.2°	61.1°	118.1°	265.7	.6082	573.5	3.904	.0001469
15	5.0	226.1°	35.9°	138.9°	56.9°	103.0°	266.7	.5176	501.2	3.613	.0001355
16	5.0	227.1°	40.5°	143.5°	55.9°	103.0°	260.0	.5090	491.6	3.639	.0001400
17	5.0	226.8°	40.2°	141.6°	56.3°	101.4°	267.0	.5116	496.1	3.650	.0001367
18	14.5	249.9°	39.0°	161.0°	56.9°	122.0°	206.0	.4914	465.3	3.104	.0001506
19	14.5	249.4°	39.8°	162.2°	58.0°	122.4°	201.2	.4836	456.2	3.074	.0001528
20	14.3	249.6°	41.0°	160.0°	55.9°	119.0°	206.7	.4856	456.6	3.073	.0001486
21	5.0	227.5°	15.5°	137.1°	56.5°	121.6°	197.0	.4428	432.7	2.861	.0001452
22	5.0	227.5°	14.0°	136.1°	56.4°	122.1°	198.5	.4470	437.0	2.868	.0001445
23	5.0	226.9°	13.2°	135.7°	55.9°	122.5°	197.7	.4464	436.6	2.865	.0001449
24	5.0	227.5°	13.5°	136.1°	56.0°	122.6°	199.0	.4504	439.8	2.880	.0001448
25	4.34	224.5°	27.8°	140.9°	56.9°	113.1°	225.0	.4798	463.3	3.306	.0001469
26	4.0	223.9°	28.3°	141.3°	58.0°	113.0°	252.7	.5350	518.3	3.726	.0001475
27	4.0	224.2°	28.0°	141.3°	58.7°	113.3°	249.5	.5290	512.7	3.675	.0001473
28	4.0	224.4°	27.7°	141.3°	59.5°	113.6°	253.1	.5378	520.8	3.723	.0001471

TESTS OF INDIRECT LONG PIN RADIATORS.

Prof. John R. Allen.

Number.	Gauge pressure.	Entering Steam (T_7).	Entering Air Average (T_1 and T_2).	Leaving Air Average (T_3 and T_4).	Room Temperature Average (T_5 and T_6).	Increase in Temperature of Air.	Cu. ft. Air per hr. per sq. ft. Surface (rated).	Lbs. Steam per hr. per sq. ft. Surface (rated).	B.T.U.'s per hr. per sq. ft. (rated).	B.T.U.'s per hr. per deg. diff. av. Air and Steam per sq. ft. (rated).	B.T.U.'s per hr. per deg. diff. av. Air and Steam per cu. ft. Air per sq. ft. Surface (rated).
29	5.14	227.2°	25.9°	133.7°	65.0°	107.8	198.9	.4142	386.6	2.684	.0001350
30	5.04	227.3°	25.9°	133.8°	65.4°	107.9	206.5	.4196	400.6	2.718	.0001316
31	5.27	227.6°	22.5°	132.6°	69.2°	110.1	201.4	.4142	395.5	2.635	.0001318
32	5.3	227.7°	21.3°	132.9°	67.7°	116.6	202.6	.423	403.8	2.681	.0001323
33	5.3	227.5°	18.0°	130.9°	64.7°	112.9	203.9	.430	411.2	2.687	.0001318
34	5.4	227.8°	65.6°	151.5°	65.9°	85.9	175.2	.300	286.6	2.404	.0001372
35	5.4	227.7°	65.4°	152.1°	66.1°	86.7	172.2	.298	284 6	2.392	.0001389
36	5.4	227.9°	66.0°	152.7°	67.2°	86.7	171.7	.297	283.5	2.372	.0001381
37	5.2	227.7°	39.2°	141.0°	72.6°	101.8	198.7	.383	365.7	2.658	.0001338
38	5.26	228.1°	39.6°	141.4°	73.6°	101.8	196.5	.378	361.4	2.626	.0001336
39	5.2	228.5°	38.5°	140.7°	73.2°	102.2	196.8	.380	363.2	2.615	.0001328
40	5.06	227.6°	38.4°	134.1°	69.9°	95.7	259.2	.460	446.9	3.163	.0001220
41	5.2	227.8°	38.8°	134.5°	70.9°	95.7	255.0	.460	439.3	3.109	.0001219
42	5.2	227.7°	38.8°	134.6°	71.4°	95.8	258.0	.466	444.7	3.154	.0001222
43	5.25	227.4°	25.2°	126.9°	68.3°	101.7	263.1	.479	477.0	3.153	.0001199
44	5.3	227.0°	24.1°	126.3°	66.3°	102.2	267.3	.509	487.6	3.212	.0001202
45.	5.2	227.9°	23.5°	126.1°	65.0°	102.6	267.1	.510	489.5	3.197	.0001197
46	14.98	249.6°	39.9°	152.4°	66.8°	112.5	200.0	.438	411.7	2.684	.0001342
47	14.98	249.9°	40.1°	152.6°	68.4°	112.5	200.0	.438	411.1	3.226	.0001339
48	15.0	249.8°	38.9°	145.8°	69.0°	106.9	262.4	.540	507.7	3.158	.0001229
49	14.9	250.1°	38.8°	145.9°	68.6°	107.1	257.0	.530	498.5	2.707	.0001229
50	5.3	228.0°	17.5°	131.0°	62.3°	113.5	204.7	.436	416.1	2.751	.0001323
51	5.4	228.2°	17.5°	130.6°	61.8°	113.1	209.3	.444	424.0	2.539	.0001315
52	15.2	250.1°	64.8°	162.6°	66.5°	97.8	187.2	.369	346.3	2.543	.0001357
53	15.1	249.7°	64.5°	163.2°	64.4°	98.7	184.3	.368	345.6	2.303	.0001380
54	5.23	227.6°	29.7°	138.9°	65.5°	109.2	166.7	.346	330.0	2.340	.0001382
55	5.39	227.7°	28.2°	138.4°	62.4°	110.2	168.7	.354	338.0	2.369	.0001388
56	5.4	227.2°	27.5°	138.3°	62.3°	110.8	169.8	.358	341.9	2.402	.0001395
57	5.0	227.5°	39.0°	140.8°	64.3°	101.8	177.1	.346	330.5	2.405	.0001357
58	5.0	227.5°	39.3°	141.8°	64.4°	102.5	175.0	.345	329.3	2.405	.0001374
59	5.03	227.5°	38.6°	142.2°	65.0°	103.6	173.3	.345	329.0	2.400	.0001385
60	5.1	227.5°	40.9°	141.9°	66.1°	101.0	180.1	.349	333.3	2.447	.0001359
61	15.0	250.7°	39.3°	156.9°	70.6°	117.6	168.9	.388	363.7	2.383	.0001411
62	14.9	250.3°	38.2°	156.2°	69.2°	118.0	167.2	.385	361.5	2.361	.0001413
63	14.9	250.5°	39.5°	157.0°	68.9°	117.5	166.0	.382	358.4	2.355	.0001418
64	5.5	228.5°	28.2°	133.0°	67.9°	104.8	227.9	.451	430.4	2.910	.0001277
65	5.58	227.8°	27.5°	136.6°	66.4°	104.1	232.5	.457	436.4	2.952	.0001267
66	5.58	227.7°	27.5°	131.5°	64.5°	104.0	233.7	.458	437.1	2.950	.0001262
67	5.55	228.1°	38.4°	136.4°	67.4°	98.0	229.1	.427	407.1	2.889	.0001261
68	5.58	228.4°	38.2°	136.6°	65.8°	98.4	229.8	.430	410.4	2.911	.0001267
69	5.58	228.3°	38.3°	136.8°	64.9°	98.5	230.9	.433	413.3	2.948	.0001276
70	5.36	228.3°	39.8°	144.0°	64.5°	104.2	158.4	.319	304.4	2.221	.0001402
71	5.5	228.5°	39.0°	144.8°	64.2°	105.8	154.8	.317	302.0	2.212	.0001429
72	5.5	228.3°	39.2°	145.5°	62.7°	106.3	151.4	.312	298.0	2.193	.0001448
73	5.5	228.5°	38.2°	145.0°	63.4°	106.8	153.3	.317	302.3	2.208	.0001440
74	5.51	228.4°	54.4°	147.5°	66.3°	93.1	171.2	.312	298.2	2.339	.0001366
75	5.6	228.1°	54.7°	147.8°	66.4°	93.1	171.2	.312	298.3	2.352	.0001374
76	5.6	227.9°	55.3°	149.0	67.4°	93.7	169.6	.311	297.4	2.364	.0001394
77	5.0	228.2°	38.7°	134.1°	59.1°	95.4	238.2	.435	415.3	2.929	.0001229
78	5.23	228.0°	38.4°	134.5°	58.0°	96.1	239.1	.440	420.2	2.970	.0001242
79	4.27	227.5°	38.8°	134.5°	57.3°	95.7	244.1	.448	427.6	3.037	.0001244
80	5.3	226.8°	39.4°	134.3°	56.1°	94.9	240.0	.436	417.8	2.986	.0001245
81	5.64	228.0°	40.7°	151.9°	62.5°	111.2	103.4	.229	218.1	1.656	.0001602
82	5.7	227.6°	39.9°	150.7°	61.6°	110.8	100.1	.221	210.8	1.593	.0001592
83	5.74	227.7°	39.3°	150.2°	60.8°	110.9	100.7	.222	212.3	1.598	.0001587

TEMPERATURE CODE FOR TESTING HEATING SYSTEMS.

At the annual meeting in January, 1909, the following topic (No. 10) was brought up for discussion:

"A table or sliding scale of indoor and outdoor temperatures for gauging the capacity of heating plants to maintain a 70 degree temperature inside with the outside temperature at zero, this to be established by the Society so that it could be widely incorporated in heating specifications, and add to the Society's prestige."

Mr. Barwick made a motion, which was agreed to by the Society, to the effect that a committee be appointed to review the subject, obtain such information as is available and report at a following meeting. In accordance with this motion President Snow asked the Committee on Tests to assume the responsibility, which it has done, with the following results:

At the semi-annual meeting of the Society in July, 1903, the Committee on Standards made a very complete report upon this subject to the Society. In this report the following equation was used to give for any room the required inside temperature during test, at any given outside temperature, so that the requirements of the heating system would be the same as if tested in a room with 70 degres inside temperature when the outside temperature was zero.

$$t = 70 + \frac{(T - 70)\, t_0}{T}$$

where t = temperature to be maintained in room during test; T = temperature of the steam or hot water in the radiators, and t_0 = outside temperature during test.

Some of the important points in the Code were as follows: First, "The temperature of the steam or water maintained in the radiators shall be the same as that allowed by the contract to be maintained in order to maintain a temperature of 70 degrees in the building when it is zero outside; second, the difference between the temperature of the steam or water in the radiator, and the temperature maintained inside of the building during the test, shall not be less than 0.8 of the difference between the temperature of the steam or water in the radiator

and the temperature to be maintained in the building when it is zero outside; third, in no case shall the temperature outside be greater than 48 degrees, even although the allowable temperature under the second requirement should be greater than 48 dgrees." In addition to these points the Committee on Standards included minute directions for conducting such tests.

The report above referred to expressed the opinion that heating plants, heating buildings by indirect methods, could not be tested when the outside temperature was above zero and show the capacity of the plant with 70 degrees inside when the outside temperature is zero.

Your Committee on Tests begs permission to present a temperature table which has been worked up from the formula given above, and which will probably be applied more quickly than the formula. This table and formula may be used only in case of direct radiation, steam or hot water, and should show the relative capacity of the radiation, although not necessarily showing the capacity of the boiler.

TABLE II.

A Table of Indoor and Outdoor Temperatures Showing Equivalent Heating Capacity to 70° Inside and 0° Outside.

Temp. of Radiator	160°	170°	180°	190°	200°	210°	220°	230°	240°
			Room Temperatures Fahr.						
Outside Temperatures. 0°	70.°	70.°	70.°	70.°	70.°	70.°	70.°	70.°	70.°
2°	71.1	71.2	71.2	71.2	71.3	71.3	71.3	71.4	71.4
4°	72.2	72.3	72.4	72.5	72.6	72.7	72.7	72.8	72.8
6°	73.4	73.5	73.7	73.8	73.9	74.	74.1	74.2	74.2
8°	74.5	74.7	74.9	75.	75.2	75.3	75.5	75.6	75.7
10°	75.6	75.9	76.1	76.3	76.5	76.7	76.8	77.	77.1
12°	76.7	77.	77.3	77.6	77.8	78.	78.2	78.3	78.5
14°	77.9	78.2	78.5	78.8	79.1	79.3	79.5	79.7	79.9
16°	79.	79.4	79.7	80.2	80.4	80.7	80.9	81.1	81.3
18°	80.1	80.5	81.	81.3	81.7	82.	82.3	82.5	82.7
20°	81.2	81.7	82.2	82.6	83.	83.3	83.6	83.9	84.1
22°	82.3	83.	83.4	83.9	84.3	84.7	85.	85.3	85.5
24°	83.5	84.1	84.6	85.1	85.6	86.	86.4	86.7	87.
26°	84.6	85.3	85.9	86.4	86.9	87.3	87.7	88.1	88.4
28°	85.7	86.5	87.1	87.7	88.2	88.6	89.1	89.5	89.8
30°	86.9	87.6	88.3	89.	89.5	90.	90.4	90.9	91.2
32°	88.	88.8	89.5	90.2	90.8	91.4	91.8	92.2	92.6
34°	....	90.	90.8	91.5	92.1	92.6	93.2	93.6	94.
36°	....	....	92.	92.8	93.4	94.	94.5	95.	95.4
38°	....	....	....	94.	94.7	95.4	95.9	96.4	96.9
40°	....	....	....	....	96.	96.6	97.2	97.8	98.3
42°	....	....	....	....	....	98.	98.6	99.2	99.9
44°	....	....	....	....	....	....	100.	100.6	101.2
46°	....	....	....	....	....	....	....	102.	102.6
48°	....	....	....	....	....	....	....	....	104.

At the semi-annual meeting of 1908 Mr. Macon offered a topical discussion upon the same subject and presented tables

for steam and hot water radiation plants, such that the pressure range for steam systems was from 10 inches vacuum to 10 pounds gauge. He also supplemented the tables by a chart used by Captain Emile Mathieu, Instructor at the Military School of Belgium (published in *L'Hygiene du Bâtiment,* for July).

Your Committee on Tests has compared the table derived from the Code report and the chart last referred to, and has found that they check almost exactly, showing that the two are derived from the same theoretical basis.

In the same year (1908) Professor Allen presented a paper on "Coefficients of Transmission in Cast-Iron Radiation," which checks with the formula and temperature chart fully as well as the values given in Mr. Macon's paper, there being not greater than one degree difference in any calculation.

Respectfully submitted,

J. D. HOFFMAN, *Chairman,*
THEO. WEINSHANK,
Committee.

DISCUSSION.

Professor Hoffman: The committee report quoted first in the Committee of Tests report gave specific directions, if I am not mistaken, as to where the temperature should be taken, how high the thermometer should be carried, etc.; and as I understood from the President, it was not the office of the Committee of Tests to go further than to merely report what had been done. The Committee of Tests merely worked out a table of temperatures from the formula given, and no new material whatever is given in this committee report on tests, further than to offer that table in preference to the formula given.

Mr. Bolton: I would ask whether the committee took into account the effect of wind pressures and leakage in connection with the tests of their radiators under given conditions, which seems to me especially important in this section of the country. Zero weather is very rare in New York, and I can find no record of its having existed after nine o'clock in the morning. But I do find that we have had several occasions when the tem-

perature has approached within 20 degrees of zero and the wind speed has been as much as twenty miles an hour. We had a low temperature within the last month, of six degrees above zero in the early morning, which rose to twelve degrees in the middle of the day, and the wind speed was from twenty to twenty-four miles an hour. Under these circumstances four or five of the largest buildings in the city provided with heating apparatus on standard systems entirely failed to maintain the necessary interior temperature, and in more than one of these buildings some of the radiators actually froze. Our committee might devote further attention to this phase of the subject, although their report, so far as presented, is most admirable.

On motion the report was ordered received and placed on file.

President Snow: We have now reached the point in the programme, Reports of Special Committees, and the Secretary states that Mr. Feldman has a statement to make in regard to the committee to gather data in regard to appliances and methods of operation of mechanical vacuum systems.

Mr. Feldman: In regard to this report, I received notice only four weeks ago that I was appointed on the committee, then the chairman said that he resigned. Last week I was notified that I was chairman. I began to collect data, but did not go far enough. I recommend that two more members be elected, because the subject is very important, and that progress be reported until the next meeting. I move that the chairman appoint three members instead of one member of the committee.

President Snow: In other words, that a committee of three be appointed by the incoming president to take up this work?

Mr. Feldman: Yes.

The motion was seconded and carried.

President Snow: The special committee of auditors has examined the books and vouchers of the Treasurer and are prepared to report. I will call on the chairman of the Auditing Committee to report to the meeting.

Mr. McCann: The Auditing Committee report that they examined the books and vouchers presented by the Treasurer and found everything correct.

Under the head of new business the President received a

letter from Mr. A. M. Mattock, Jr., Chairman of the Entertainment Committee of the American Society of Plumbing Inspectors. They wish to extend to our members a cordial invitation to attend their convention, which will be held at Trenton, N. J., on January 20, 21 and 22. Our members are welcome to all meetings.

Under new business Mr. Seward was told by the chair that a resolution would be received and he presented to the Society the following:

RESOLVED, That a committee be appointed to investigate the purpose of the constitution on certain points which do not seem to be clear, and report its interpretation on those points.

Mr. Chew moved to adopt the resolution. Motion seconded.

Professor Hoffman: The constitution is rather long. It seems to me there should be something definitely stated as to what parts of the constitution are not clear. Some one member of the committee may consider that one part is indefinite, while another may consider that it is all right; and I think that such portions as we as a body feel are not clear should be definitely stated in that resolution, otherwise it would be very vague.

President Snow: The chair states that it is his belief that if this resolution should prevail, that the committee would then be empowered to take up and consider any questions which were presented to it by the various members in good standing of the Society which were not clear to those particular members and pass on those points.

Professor Hoffman: This, then, would be a committee which would hold throughout the year?

President Snow: No, it is intended to report back to the Society at its next meeting. It is merely to carefully study the subject and make its own interpretations and report these interpretations back to the Society for such further action as the Society may see fit to take.

Mr. Donnelly: I would like to make an amendment to that rather extending the scope, to the effect that the committee be also requested to report some method of safeguarding the members in relation to papers presented as well as safeguarding the Society.

Motion seconded by Mr. Barron.

After some discussion by Messrs. Weinshank, Chew and Donnelly, Mr. Donnelly and Mr. Barron withdrew the amendment.

The question on the motion was put and carried.

The report of the Illinois Chapter was read by Mr. Lewis in the absence of Mr. Hale.

REPORT OF THE ILLINOIS CHAPTER.

Since the last report made by the Illinois Chapter regular monthly meetings have been held, except during the summer months. Papers have been read and discussed to the profit of all.

The Illinois Chapter co-operated financially with the Entertainment Committee at Indianapolis, and several Chicago members were present as members of that committee.

It is with deep regret that we have to report the death of one of our charter members, a man much beloved and revered, one who has been identified with the Society of Heating and Ventilating Engineers since its organization in 1894, and who up to the time of his death was one of its most enthusiastic workers. I refer to Thomas J. Waters, Chief Engineer of the Board of Education of the City of Chicago.

The March and April meetings were devoted almost exclusively to the discussion of Mr. Waters' achievements in the engineering field, the April meeting being known as "The Thomas J. Waters Memorial Meeting," at which the President and many of the members told of interesting incidents in the life of the deceased.

The Illinois Chapter joined with the Board of Governors of this Society in the presentation of engrossed resolutions, these being made upon vellum paper and bound in leather and reading as follows:

"At a special meeting of the Illinois Chapter of the American Society of Heating and Ventilating Engineers held April 12, 1909, the following resolution was unanimously adopted:

"*Whereas,* Thomas J. Waters, a charter member of this Chapter, passed from this life on February 25, 1909, and by his untimely death we have sustained a great loss; and

"*Whereas,* He was at all times devoted to the welfare of the Chapter, generous of his time and resources, wise of counsel, of great integrity, fair-minded and courteous in all his relations, and by his kindly nature endeared himself to those with whom he came in contact; be it

"RESOLVED, That out of respect to his memory and in token of the deep sympathy which we feel toward his widow and family, it is hereby ordered that this resolution be spread upon the records of the Chapter and an engrossed copy be transmitted to the widow."

The subject of our May meeting was "Air Washers," the principal paper on the subject being read by Mr. W. L. Bronaugh. This in a general way described the evolution of the modern devices for this purpose and contained much interesting matter. It is the writer's understanding that a copy of this paper was given to the Chairman of the Air Washers Committee, and will be incorporated in his report.

At the October meeting of the Illinois Chapter new officers for the present year were elected, these being as follows:

EDMUND F. CAPRON, President,
N. L. PATTERSON, Vice-President,
AUGUST KEHM, Treasurer,
JOHN F. HALE, Secretary.

BOARD OF GOVERNORS.

JAMES MACKAY,
R. A. WIDDICOMBE,
J. P. DUGGER.

We have in our local Chapter the following committees:

Tests: James M. Stannard, Chairman; N. L. Patterson, Charles F. Newport.

Smoke Prevention: August Kehm, Chairman; James Mackay, R. A. Widdicombe.

Compulsory Legislation: George Mehring, Chairman; Samuel R. Lewis, James Mackay.

On November 8, 1909, the Illinois Chapter held its regular monthly meeting in the rooms of the Western Society of Engi-

neers, at which the principal speaker of the evening was Mr. Paul P. Bird, Chief Smoke Inspector of the City of Chicago, and there were present at this meeting representatives from the Smoke Department, City Boiler Inspection Department and the Health Department, as well as many architects, engineers and contractors. The discussion which followed Mr. Bird's remarks was very spirited and brought forth many points in reference to the prevention of smoke and the adaptability of the various types of stokers and smoke consumers. One statement made by Mr. Bird which stands out beyond all others is that the greatest requirement in the prevention of smoke is proper flue area, height of stack and reasonable draft, as, without these, it is impossible even with the best mechanical device to give perfect results.

The December meeting, held on December 13, 1909, contained many very interesting features, the principal speaker of the evening being Mr. James M. Stannard, Chairman of Committee on Tests for the Illinois Chapter. Mr. Stannard read a very able paper on the subject of steam pumps, describing the relative merits of the various types of pumps on the market to-day, which paper is available for use in the Society records if it is desired.

The report made by the Committee giving the tests made of a steam heating apparatus during the summer months and the corresponding test during zero weather, brought out some very peculiar facts, showing that the formulæ given by several authorities on the subject did not work out in practice. A more careful test of this subject is to be made by our Committee, and the results will be given to the National Committee on Tests in due time.

On January 11, 1910, Illinois Chapter held its monthly meeting in the rooms of the Chicago Architectural Club, the subject of the evening being "Ventilation in Public Schools." The speakers of the evening were Dr. Evans, of the Chicago Board of Health, and Dr. Hurty, Health Commissioner of the State of Indiana. We also had present with us Dr. Winslow, of the Institute of Technology, Boston; Dr. Ball, Chief Sanitary Inspector of the City of Chicago; Dwight H. Perkins, Architect for the Board of Education; N. L. Patterson, Chief Engineer for the

Board of Education, in addition to many engineers, contractors and architects. The discussion which followed the principal talk by Dr. Evans was very spirited and interesting, and as a result of the suggestion by Dr. Evans a resolution was passed that the Chapter should appoint a committee of three of its members to co-operate with a committee of three to be appointed by the Health Department; these six men to make a careful research into the ventilation requirements in schools and other public buildings, and determine if possible the best method of getting perfect ventilation. Up to the present time this committee has not been appointed.

We wish to report a very healthy condition of the Illinois Chapter in every respect. Our expenses have been small, as most of the meetings have been held around the dinner table, each member paying his share. As a result, we have a very respectable amount in our treasury, which will be available for use in attempting to get a ventilation law introduced into our State Legislature, and for use in connection with the committee above referred to. We have at the present time twenty-nine active members and four associate members, having lost one member by death during the past year, and having elected two to membership.

We have in prospect for a subsequent meeting a contest among the members in which plans and specifications will be submitted for the installation of the heating and ventilating apparatus in a small bank building. This contest will be competitive, prizes to be given for excellence in design. A full and complete report in reference to this feature will be given at the next annual meeting.

Respectfully submitted,

JOHN F. HALE, *Secretary.*

CHICAGO, January 15, 1910.

Mr. Lewis: I would like to mention one feature of our chapter meetings that we have enjoyed, that a number of members bring plans of buildings and jobs that they have installed and pin them upon the wall and tell about what happened, how they worked; and we get a great deal of help and mutual benefit from that work.

On motion the report was ordered received and placed on file.

The Secretary read invitations from various points for holding the summer meeting of the Society, especially from Rochester and St. Louis.

President Snow: There is no comment necessary on these papers, and they will be turned over to the Board of Governors to decide on the place and time of the summer meeting.

The Board of Governors at their last meeting requested the chair to announce that the dignity of these proceedings would be enhanced by the absence of trade literature in the seats, and that a table is provided outside the meeting room for any distribution of literature.

On motion adjourned till 8 P.M.

FIRST DAY—EVENING SESSION.

(Tuesday, January 18, 1910.)

The meeting was called to order at 8.25 P.M. by President Snow.

The report of the tellers was read by Mr. Munroe and President Snow announced the officers therein named duly elected to office, to take office at the last session of the meeting.

NEW YORK, January 18, 1910.

The tellers for the annual election of the A. S. H. & V. Engineers respectfully submit the following names of officers for the ensuing year, the same having been duly elected by a majority of the votes cast:

President.

James D. Hoffman 109

First Vice-President.

Reginald P. Bolton 96

Second Vice-President.

Samuel R. Lewis 92

Secretary.

William M. Mackay 154

Treasurer.

U. G. Scollay	133

Board of Governors.

R. C. Carpenter	143
James Mackay	127
Judson A. Goodrich	101
John F. Hale	86
George W. Barr	65

Respectfully,

ED. K. MUNROE,
SAM. KAUFFMAN,
F. F. MACNICHOL,
Tellers.

The other candidates received votes as follows:

August Kehm, Chicago, Ill., for president, 55.

Burt S. Harrison, New York, for first vice-president, 66.

John R. Allen, Ann Arbor, Mich., for second vice-president, 70.

Samuel C. Parter, New York, for secretary, 8.

T. B. Cryer, Newark, N. J., for treasurer, 24.

For Board of Governors: William Nelson Haden, Trowbridge, England, 62; Bert C. Davis, Kansas City, Mo., 63; Fred R. Still, Detroit, Mich., 58; James H. Davis, Chicago, Ill., 54; William K. Downey, Milwaukee, Wis., 39.

President Snow: In the matter of business this evening comes the report of the Committee on Air Washers, Mr. Lewis, Chairman, and the report of the Committee on Standards with reference to House Heating Boiler Rating, Mr. Kinealy, Chairman. I note in the audience a number of members of our brother association, the Master Steamfitters, some members of the Standardization Committee, and a number of people who are distinctly interested in this matter of standards with reference to house heating boiler rating, and if there is no objection, as we frequently do interchange the subjects, I will put the report of

the Committee on Boiler Ratings in advance of the one on Air Washers, in order that it may have the benefit of ample time for discussion.

In connection with that question the Secretary has two minority reports, which I will rule will be read just after this committee report is rendered and before the matter is opened for discussion. I will ask Mr. Smith, in the absence of Professor Kinealy, to read this report.

The report of Committee on Standards with reference to House Heating Boiler Ratings was read by Mr. Smith.

President Snow: I will ask the Secretary to read the letter he has received from Mr. E. D. Densmore, a member of the Committee on Standards, who acted with this general committee in the matter of boiler rating.

The letter was read by the Secretary.

President Snow: I will ask Mr. Seward to read his minority report. The Secretary, I think, has copies of it.

The report was read by Mr. Seward.

President Snow: This entire matter, gentlemen, is now open for discussion. I wish to state that the privileges of the floor, according to the custom of this Society, are accorded to our guests who are interested in this subject, and we would be pleased to have them enter the discussion, if they see fit to do so.

The report was discussed by Messrs. May, H. A. Smith, R. C. Carpenter, Weinshank, Barron, Seward, James Mackay, Gates, Macon, Berry, and Badger.

President Snow: We will now put the motion as amended. The motion with the amendment is: "That the Society receive all the reports covering the rating of heating boilers and that these, together with all data pertaining thereto, be referred to a committee to recommend to the Society a method for rating heating boilers, this committee to be appointed by the incoming president." That is the question before you.

The motion was put and carried.

President Snow: If there is nothing further on this matter, we will pass on to the report of the Review Committee for 1909 on Heating Boilers, in order to conclude this matter of heating boilers to-night.

The report was read by Mr. Seward.

Mr. James Mackay: This paper is a very good paper, because it gives us some data that will be useful in further consideration of the subject. I move that the paper be accepted and the committee be discharged with thanks.

Mr. Chew: I would like to make a motion, if it is in order at this time. Inasmuch as a printed minority report has been submitted at the expense of one of the members, and which is of benefit to the Society, I move that the Board of Governors be requested to pay Mr. Seward whatever it has cost him to have the minority report printed at this meeting.

The motion was seconded and carried.

On motion an adjournment was taken until Wednesday.

Second Day—Afternoon Session.

Wednesday, January 19, 1910.

The meeting was called to order at 2.15 P.M. by President Snow.

The Secretary read a telegram from Purdue University congratulating the Society and Professor Hoffman on his election as president.

The President announced that a committee from the National Association of Master Steam and Hot Water Fitters was giving its attention to boiler ratings, and had requested that topic No. 1, "Methods for Testing House Heating Boilers to Get the Most Accurate Results," be taken up and discussed.

The topic was discussed by Messrs. May, Barron, Chew, Seward, Quay, Cryer and Blackmore.

President Snow: If there is no further discussion of this topic No. 1 we will pass to the first number on the programme, namely, "Report of Committee on Air Washers, Mr. S. R. Lewis, Chairman."

The report was read by Mr. Lewis, and discussed by Messrs. Kauffman, Lewis, Berry, Bolton and Lyle.

The question on the acceptance of the report was called for.

President Snow: I rule in these matters that all these papers go to the Publication Committee, which safeguards the interests

of the Society, and that they sometimes find it expedient and, in their opinion, for the best interests of the Society, to refer the matter to a committee to make further changes. I think that has been the custom in the past. The Publication Committee stands sponsor for everything that appears in the Transactions, so that this report would naturally go through the Publication Committee before it is finally published, just as in the case of the American Society of Mechanical Engineers, that everything passes through its Publication Committee, although it has previously gone through a committee called the Meeting Committee. We have only one committee, the Publication Committee, which passes on papers before they are presented, and which looks after the editing of them after they are printed. The question now is on Mr. Weinshank's motion, that this report of the Committee on Air Washers be received.

The motion put and carried.

President Snow: The paper entitled, "A Method of Determining the Sizes of the Pipes of a Hot Water Apparatus," by J. Jeffreys, London, England, will now be read by Mr. Macon.

The paper was read in abstract by Mr. Macon, and discussed by Messrs. Cary, Macon and Quay.

President Snow: If there is no further discussion, we will now have a report on "Hot Water Heating" by Mr. William M. Mackay, Chairman.

The report was read by Mr. Mackay.

On motion the report was ordered received and handed to the Publication Committee.

President Snow: The next on the programme is a report on "Steam Heating for Residences and Small Buildings," Charles F. Newport, Chairman.

The report was read by Mr. Chew in the absence of Mr. Newport, and on motion it was received and referred to the Publication Committee.

President Snow: The next paper is a committee report by the Review Committee on "Furnace Heating," Professor James D. Hoffman, Chairman.

The report was read by Professor Hoffman.

On motion the report was accepted and passed to the Publication Committee.

President Snow: We will now take up topic No. 2 for discussion, "The Influence of Low Pressure or Vapor Vacuum Systems Toward Lifting Water from the Boiler to the Mains and Radiators."

The topic was discussed by Messrs. George D. Hoffman and Paul.

President Snow: If there are no further remarks on this topic we will take up No. 3, "The Amount of Water to be Evaporated to Maintain a Proper Humidity in a Home in Zero Weather."

The topic was discussed by Professor Hoffman and Messrs. Chew, Feldman and Collamore.

On motion an adjournment was taken until Thursday morning.

THIRD DAY—MORNING SESSION.

(Thursday, January 20, 1910.)

The meeting was called to order at 10.55 A.M. by President Snow.

Professor William Kent read a paper on "Performance of Heating Guarantees."

The paper was discussed by Messrs. J. D. Hoffman, Macon, Donnelly, Collamore, Bushnell, McCann and Quay.

President Snow: The next order of business is "Report of Special Review Committee on Tests," Mr. D. D. Kimball, Chairman.

The report was read by Mr. Kimball.

On motion the report was ordered received and passed to the Publication Committee.

President Snow: The next is "Report of Special Review Meeting Committee on Standards." Professor Carpenter has been called away and asked me last night to make a statement that, owing to conditions over which he has no control, it has been impossible for him to get his report into shape for presentation to this meeting, and stated that he had collected a good deal of valuable information, and that he would put it in shape

in time for the summer meeting, so that later, at the discretion of the President, he may be reappointed to continue this work.

The next is the "Review Committee Report on Fans and Fan Systems," by B. S. Harrison. In the absence of Mr. Harrison we will pass this paper and take up the Review Committee Report by Mr. W. W. Macon on "Radiators and Heaters."

Mr. Macon stated that the report was not ready for presentation, and promised to bring it in as soon as possible.

President Snow: I will ask Mr. Donnelly to read the report of the Committee on "Corrosion of Wrought Iron and Steel Pipes."

The paper was read by Mr. Donnelly.

On motion the paper was ordered received and passed to the Publication Committee.

President Snow: We will now take up topic No. 4, "The Proper Method of Determining the Size of Mains in Heating Systems Using a Forced Circulation of Hot Water." If there is no discussion we will take up Mr. Quay's motion, that the question as to air leakage and wind velocities in connection with guarantees of heating systems be referred to a committee to be appointed by the incoming president.

The motion was seconded, put and carried.

President Snow: In regard to the Review Committee on Fans and Fan Systems, Mr. B. S. Harrison, Chairman, has just telephoned, stating that he wishes to put the data that he has accumulated in better shape before presenting the report. He wishes to present it at the summer meeting.

We will now pass to the next topic, No. 5, "The Relative Efficiency of Exhaust and Live Steam in Heating."

The topic was discussed by Messrs. Kimball, Weinshank, Kent, Donnelly, Barron, Quay and Stevens.

On motion the meeting adjourned until 2 P.M.

THIRD DAY—AFTERNOON SESSION.

(Thursday, January 20, 1910.)

The meeting was called to order at 2 P.M. by President Snow.

President Snow: We will continue from this morning the discussion of topic No. 5.

The topic was further discussed by Messrs. Paul and Donnelly.

President Snow: Mr. Mackay has a motion to make, which is customary at this time, in order to relieve the incoming president from the effect of any errors of commission or omission on the part of the previous presiding officer.

Secretary Mackay: I move that it is the sense of this meeting that the regular standing committees, Compulsory Legislation, Standards and Tests, be continued with such change in personnel as may be found desirable, and that the newly elected president shall continue all such special committees as may be authorized by the Society or fill vacancies in the same as he may consider necessary in the offices of this Society, and that such special committees as have completed their duties or are not considered necessary be discharged with the thanks of the Society.

The motion was seconded and carried.

President Snow: We will now call on Mr. H. W. Whitten for his paper on "Variability of Interior Conditions in School Rooms."

The paper was read by Mr. Whitten and discussed by Messrs. Barron, Hoffman, Myrick, Whitten, Cary, Lewis and Collamore.

During the discussion Mr. Myrick moved that the question whether the quantity of air supplied to a school room be measured at the inlet or the outlet be referred to the Committee on Tests.

Seconded and carried.

President Snow: We will now proceed to the installation of officers.

I will request past President Quay and past President Kent to escort Professor James D. Hoffman to the platform.

All the newly elected officers and members of the Executive Committee were escorted to the platform and inducted into office by President Snow.

Professor James D. Hoffman, president-elect, assumes the chair.

President Hoffman: I presume that no words of mine can express my appreciation of the honor that you have conferred upon me. It is my great pleasure and my great privilege to be

before you as the one chosen to stand with you this coming year. I shall attempt to do it to the best of my ability, hoping of course that we may, from the best efforts that I have within me, do as well as we have done in the past year, and if you will give me your undivided assistance, probably excel your former efforts. I do not care to take up your time in making any set speech. I merely again wish to thank you for the very great kindness and for the courtesy and the honor, and will take up the work of the day towards completion as it is given on the programme.

The next in the line of the programme is the report of the Special Review Meeting Committees. We will hear first the report of the "Committee on Compulsory Legislation," by Mr. John F. Hale, Chairman.

The report was read by Mr. Hale.

On motion the report was accepted and the committee given a vote of thanks. It was discussed by Messrs. James Mackay, Barron, Myrick, Whitten and Kent.

Mr. Snow: There are a few necessary motions in order that the Society may continue its business next year.

In the first place Mr. Macon submitted a report this morning that is in such shape that it may be received subject to revision. I therefore move that his committee report be received subject to revision.

The motion was put and carried.

Mr. Snow: Mr. Thomas Barwick requested further time in which to prepare his review paper on ventilation in general. I therefore move that a Review Committee on Ventilation in General be appointed by the President.

Motion put and carried.

Mr. Snow: Professor Carpenter has stated that he wishes more time in which to prepare his report on standards, as chairman of the Review Committee. I therefore move that the President appoint a Review Committee on Standards.

Motion put and carried.

Mr. Snow: Mr. Harrison has made the same statement in regard to the Review Committee report on Fans and Fan Systems. I therefore move that the President appoint a Review Committee on Fans and Fan Systems.

Motion put and carried.

Mr. Snow: These are merely to give the incoming board the necessary authority.

I therefore move that the Committee on Legislation for New York State be appointed by the President.

Motion put and carried.

Mr. Snow: Mr. Thompson has stated that he will have further information to give as to relative corrosion of wrought iron and steel pipes. I therefore move that a committee on that subject be appointed for the coming year.

Motion put and carried.

Mr. Snow: Finally I move that a Publicity Committee, with duties similar to those with which the committee for 1909 was charged, be appointed by the President.

The motion was put and carried.

President Hoffman: I will say that these appointees will be announced to the members or to the appointees themselves within a short time, possibly a week.

We will now take up the report of the Committee on Central Heating Plants by Mr. J. R. Allen, Chairman. His report will be read by Mr. Collamore.

The report was read by Mr. Collamore, and on motion it was received and referred to the Publication Committee.

I will now call for the report of the Publicity Committee, Mr. S. R. Lewis, Chairman.

Mr. Lewis: The Publicity Committee is so lately organized that we have not thought it quite time to make a report. The members of the Central Committee have had several meetings and considerable correspondence, and a sub-committee has been appointed. It takes so long to get letters back and forth that even now we have not a committee member in each of the States in which we have a member of the Society. A number of them, after being appointed, say they cannot serve. So it takes some time to get the thing organized. We have sent out a number of letters to the different members, and have had replies to some of them. In all cases they have been received most courteously and the newspapers have said, "Come on with your information."

We are maintaining a scrapbook in which we will keep this

material. We had a meeting of such members of the Publicity Committee as were here yesterday, and we have framed up the first of the articles to be sent out through the sub-committee for publication.

On motion the report was ordered received and placed on file.

President Hoffman: We will now pass to the subject of "Report of Committee on Electric Heating," by Mr. T. N. Thomson, Chairman, which will be read by Mr. Macon.

The report was read by Mr. Macon.

President Hoffman: We will pass on to the next subject, "Steam Heating for Large Buildings," by John F. Hale, Chairman.

The paper was read by Mr. Hale.

Mr. Hale: I notice that the larger portion of the papers that have been written on large buildings have told all about the power plant and down at the end they have told something about the heat. Now the question is heating and not the power plant. There is another point that I have discovered in looking over the records, that there is not a single instance where a paper has been written on the subject of heating large manufacturing plants or mills—a subject that is inexhaustible—and I am very sure that there could be four or five very excellent papers written on the subject to the profit of all of us.

On motion the paper was ordered received and placed on file.

President Hoffman: I will now call for the report of the Committee to Gather Data in Regard to Appliances and Methods of Operation of Atmospheric Vacuum Systems.

No report was presented.

President Hoffman: This then completes the reports of the committees. Suppose we take up Topic No. 10, "The Objection to Placing Dampers in Heat and Vent Flues of a Fan System Reducing Their Area." Do any of the members of the Society wish to discuss that question?

The topic was discussed by Messrs. W. M. Mackay, Kent, Quay, Lewis, and Mobley.

President Hoffman: Let us pass on to No. 11, "The Relative Efficiency of 180-degree Hot Water Systems, Two-pound Gravity Steam, Steam Below Atmosphere Without Mechanical Appliances, Furnace with Outside Air Supply, Furnace with Inside

and Outside Air Supply, Furnace with Air Supply from Each Room, Furnace with Fan, and Pressure and Vacuum Steam with Fan, and Wrought and Cast Blast Heaters."

If there is no discussion we will pass on to the next, "The Relative Cost of Operating Vacuum Systems of Exhaust Steam Heating Per 1,000 Sq. Ft. of Direct Radiation with 5, 10, 15 and 20 Inches of Vacuum."

The topic was discussed by Messrs. Quay, Feldman, Stevens, Barron.

Secretary Mackay: We have a meeting of the Board of Governors after this session is closed and some of the members want to get away, and I would suggest that as some of these topics have been passed and as the members who suggested others are not present, that they go over to the summer meeting.

The motion was put and carried.

On motion the Society adjourned.

List of members and guests present at Sixteenth Annual Meeting, January 18-19-20, 1910.

MEMBERS.

Addams, Homer
Andrus, N. P.
Armagnac, A. S.
Badger, O. L.
Barr, G. W.
Barron, H. J.
Barwick, Thomas
Berry, E. S.
Birdsall, W. A.
Blackmore, J. J.
Bolton, R. P.
Boyden, D. S.
Carpenter, R. C.
Cary, A. A.
Chapman, Frank T.
Chew, Frank K.
Cripps, A. G.
Cryer, A. A.
Cryer, T. B.
Curtis, J. W.
Davis, B. C.
Davis, F. K.
Denny, E. B.
Devendorf, W. F.
Doherty, P. C.
Donnelly, J. A.
Driscoll, W. H.
Eadie, J. G.
Edgar, A. C.
Farnham, Geo. D.
Feldman, A. M.
Fox, E. E.
Gates, H. T.
Gombers, H. B.
Goodrich, J. A.
Greey, G. V.
Graham, Joseph
Greenman, G. A.
Hale, John F.
Hall, A. E.
Hankin, Richard
Harrison, B. S.
Harvey, Andrew
Hayes, J. G.
Hellerman, H. H.
Hoffman, G. D.
Hoffman, J. D.
Joannis, Harry de
Kauffman, Samuel
Kellogg, C. V.
Kiewitz, Conway
Knight, G. W.
Kimball, D. D.
Lee, H. H.
Lewis, S. R.
Lisk, J. P.
Mackay, James
Mackay, W. M.
MacNichol, F. F.
Macon, W. W.
Mallory, H. C.
Marshall, A. B.
May, E. A.
McCann, F. G.
McKiever, W. H.
Merritt, J. H.
Mobley, E. S.
Morrison, Charles
Munroe, E. K.

Myrick, J. W. H.
O'Hanlon, George
Paul, A. G.
Pelton, W. B.
Quay, D. M.
Ritchie, William
Robertson, G. A.
Scollay, U. G.
Scott, C. E.
Seward, P. H.
Sherman, L. B.
Smith, H. A.
Smith, F. W.
Snow, W. G.
Snyder, C. B. J.
Stangland, B. F.
Staten, C. H.
Stevens, F. H.
Stock, E. L.
Stockwell, W. R.
Symms, C. D.
Teran, C.
Thomson, T. N.
Vrooman, W. C.
Webster, Warren
Weinshank, Theodore
Welsh, H. S.
Whitten, H. W.
Williams, J. C.
Wilson, H. A.

GUESTS.

Anderson, J. S.
Atwood, C. P.
Baker, J. B.
Baldwin, W. J.
Baldwin, W. J., Jr.
Beach, W. R.
Bernhard, J. B.
Black, John
Braemer, Wm.
Brooks, S. H.
Burdick, F. W.
Bushnell, H. C.
Byrne, G. W.
Carney, J. F.
Chenoweth, W. H., Jr.
Cone, A.
Cooper, F. I.
Costello, J. E.
Davis, R. G.
Denning, E. M.
DuMond, A. A.
Edwards, J. E.
English, W. R.
Ensign, R. M.
Faulkner, J. C.
Fay, F. C.
Fenning, T. C.
Fisk, E. C.
Fitts, J. L.
Forgee, F. A.
Fueller, H. J.
Fuller, C. A.
Fryer, J. W.
Garfield, J. B.
Gaskill, F.
Gomee, J. D.
Gray, J. E.
Gurney, W. S.
Hairt, D. W.
Hey, J. E.
Hillman, R. W.
Howard, Geo.
Howell, F. B.
Hunt, R. B.
Hurley, E. J.
Hurrichs, H. D.
Hyman, W. M.
Kieley, T. B.
Kiewitz, A. A.
Kirk, W. P.
Kissam, C. H.
Kroepke, A. H.
Lawder, W. J.
LeCompte, W. G.
Lewen, R.
Lyle, J. I.
Lyon, D. T.
Mahaney, G. W.
Mason, W. E.
Mayo, Robt., Jr.
McDonald, S. F.
McGeorge, Harold
Miller, C. A.
Mills, F. S.
Mosner, John
Munro, W. R.
Newman, Howard
Norton, F. M.
O'Neil, A. J.
Peterson, G.
Phillips, F. T.
Quay, C. S.
Quackenboss, L. H.
Reed, R. D.
Richards, P. M.
Rielly, E. E.
Robertson, C. H.
Rome, J. W.
Seymour, C. H.
Sherwood, H. E.
Sibell, J. A.
Smith, S. C.
Spragge, E. E.
Stewart, L.
Storm, E. S.
Swain, J. A.
Textorius, K. O. B.
Thompson, J. S.
Thompson, Walter
Thurston, R.
Tweedy, E. F.
Watson, J. M.
Whitney, C. H.
Whitten, W. H.
Williamson, W. G.
Wold, C.

PAPERS

OF THE

SIXTEENTH ANNUAL MEETING,

New York, January 18-20, 1910.

CCX.

A METHOD OF DETERMINING THE SIZES OF THE PIPES OF A HOT-WATER APPARATUS.

BY J. JEFFREYS.

(Member of the Society.)

To design a hot-water apparatus in which the motive power is the difference in the weight of the water in the flow and return pipes, gravitational acceleration must be arrested, otherwise in a building of more than one floor, served by a common riser, the circulation will be too rapid in the pipes on the upper floors, while that on the lower floor may be sluggish and inefficient.

When each floor is independently served by a flow and return pipe taken directly from the boiler, assuming the distance from an adjacent boiler connection to be sufficient to prevent interference with the area of generative velocity, the difficulty does not arise, and if the pipes could be graduated in size to pass exactly the required volume of water under the head available for each floor, an apparatus so designed would heat perfectly in all parts of the system.

In large installations there are often several boilers connected with a main flow and return in the basement from which vertical risers are taken to serve radiators on the various floors. In such cases regulating valves are required to ensure a proper flow to all the circulations. Ordinarily the risers decrease in size with the height of the building in proportion to the reduced volume of water required for the upper floors, and also in an inverse proportion to the increase of head.

To apportion each floor the correct sizes of the risers, the delivery of a pipe of an assumed size, under the available head, must first be obtained from a pipe discharge diagram and if found to be in excess of what is required for the circulation,

either a smaller pipe should be selected or the pipe must be constricted in a portion of its length to the extent necessary for the desired flow. As the commercial sizes of pipes are arbitrary it is seldom possible to select a pipe just the size that is wanted, so one a little larger should be chosen and a disk or valve inserted to prevent acceleration.

A better way would be to draw down the pipe in a section of its length in the shape of a "vena contracta," so eliminating losses from change of direction, while those from friction in the contracted portion of the pipe might be neglected in practice, and the necessary calculations accordingly simplified, a method that has been adopted in the preparation of the accompanying diagram.

When a thin disk with a circular hole through its centre is inserted in a pipe for this purpose, its value for increasing the resistance to the flow of water is uncertain. It will vary in an unknown ratio with the size of the hole and the area of the pipe. If the latter is large enough in respect to the hole to allow the law of "vena contracta" to take effect, the mean velocity of the water issuing from the orifice in the plate is known to be about 0.62 of the initial velocity, from which the resistance offered by the disk can be calculated, but this condition seldom exists in the pipes of a hot-water apparatus. A practical objection to the use of a disk in a pipe is that its position cannot be easily located, while a valve or tapered pipe can be seen by inspection.

Published tables giving the frictional resistance to the flow of water in pipes appear to have been chiefly prepared from experiments with cold water, and such tables require correction for hot water as the friction is affected by the density of the liquid.

The author, many years since, prepared a set of curves for his own use, showing the friction of water in small pipes under low heads. These curves have been from time to time compared with data furnished by other investigators, also with the results obtained in practice from some hundreds of examples, and it is believed they closely approximate the conditions existing in hot-water pipes. It has been observed, however, that actual results are slightly better than those deducible from the curves, probably due to the reduced density of the hot water as compared with cold, the former averaging 60 lb. per cubic foot

for temperatures common in low pressure apparatus. The force to produce the flow and overcome the frictional resistance to the water in the pipes is shown by the curves, which will be referred to later on, in terms of the head required per 10 ft. length of pipe, figured in hundredths of an inch.

The friction in elbows, tees and valves depends to a great extent on their shape and the degree of roughness of the surfaces in contact with the water; for this reason published formulæ, obtained from practical tests, are of little use unless accompanied by a description of the fittings and the temperature of the water experimented with. For the purposes of this paper long and easy bends having a mean radius exceeding five diameters of pipe may be exempted from loss due to change of direction, and the friction may then be estimated as that of an equivalent length of straight pipe. The friction for fittings of smaller radius is arbitrarily estimated in the following multiples of the internal diameters of straight pipe, viz.:

Common elbows	= 40 diameters.
Tees and angle valves	= 60 "
Loss by entry, as from a boiler to a flow pipe	= 54 "

These figures, if approximately correct, can only be so for small fittings. In their application to large fittings the viscosity of the water would reduce the friction to some extent, but at low velocities in small pipes they will serve for practical use.

Hot-water systems are now constructed for higher temperatures than formerly, and of late years assisted circulations are common in which steam is mixed with the hot water in the flow pipe, reducing its specific gravity, thereby increasing the difference between the weight of the flow and return water, and so imparting a higher velocity to the circulation. In examples of this kind frictional losses are considerably smaller than with cold water, but further tests are necessary to determine the coefficients of friction in pipes with emulsions of low specific gravity.

In hot-water apparatus with a thermal circulation the head increases directly as the height, and the available head for any floor is that due to the difference in height of two columns of water of the respective temperatures of the flow and return, the cooler being the height of the floor measured from the centre of

the return next the boiler and the hotter in consequence of its larger volume standing higher, the difference being approximately 1.27 in. in each 10 ft. of vertical height for temperatures of 200 degrees and 170 degrees F. respectively.

This would be observable in two pipes not connected with each other, filled with equal weights of water, at the respective temperatures quoted. In a hot-water circulation this head is expressed in velocity, and work is done in overcoming friction and in producing motion of the water, which is an exact equivalent of the static head. The head being known it would appear that the size of a pipe for a given duty on any floor could be at once determined from a pipe discharge diagram, but there is another factor to be considered, viz., that of the friction in the main and risers serving the floor, which makes the effective head somewhat less than the actual head. This effective head for any part of a system is herein called the available head A as distinguished from the actual head.

If there are upper floors to be served by a rising main the volume of water it must pass to heat the radiators is that required for these floors, plus that for the floor below, to which must be added the water to compensate the heat given off by the service pipes, and the whole of this water must be delivered to the floor under consideration within the head available for that floor in order to ensure a proper flow.

The diagram shows the application of the method employed in these calculations which are based on the readings of a pipe discharge diagram and the following data:

(*a*) The actuating force producing the circulation in a hot-water apparatus is the head or difference in height of two columns of water of the respective temperatures of the flow and return, the latter measured vertically from the centre of the return pipe, where it enters the boiler, to the centre of the horizontal pipe for which the flow is to be determined. See Eq. 3.

(*b*) The theoretically attainable velocity of the water in the pipes of a heating system at ordinary temperatures is approximately 0.74 of that due to gravitational acceleration, neglecting friction. See Eq. 5.

(*c*) The velocity in a short length of pipe of "vena contracta" form is proportionate to the difference between the

available and the friction heads multiplied by a factor less than unity. See Eq. 8.

(*d*) In pipes of equal diameter the discharge varies approximately as the square root of the head.

(*e*) When diameter and discharge are constant the head varies directly as the length.

(*f*) When the head and diameter are constant, the discharge varies as the square root of the length.

(*g*) When the discharge and length are constant, the diameter varies inversely as the fifth root of the head.

(*h*) When the head and length are constant, the discharge is in the ratio of the square root of the fifth power of the diameter.

To determine (1) the amount of heating surface required to warm a room for which the loss of heat per hour in B. T. U. is known.

(2) The quantity of water per minute which must pass through a radiator or heating pipe to maintain the temperature of the heated surfaces.

(3) The sizes of the pipes in a hot-water apparatus for the required flow.

(4) The area of a constriction in a pipe of "vena contracta" form (supposed to be frictionless) to prevent gravitational acceleration when the pipe is too large for its duty, *i.e.*, when the friction of the pipe is insufficient to prevent acceleration due to the free head.

NOTATION.

Let U = British thermal units per hour required to maintain a room at a temperature T degrees Fahr.

" T = the temperature of the room when heated.

" T_1 = the mean temperature of the radiator.

" T_2 = the temperature of the flow next the boiler.

" T_3 = the temperature of the return next the boiler.

" t = the coefficient of heat transmission by the radiator per square foot of surface per hour, per degree Fahr. of difference between the mean temperature of the radiator and that of the air of the room surrounding the radiator, herein assumed at 1.5 B. T. U.

Let S = the number of square feet in the radiator.

" H = the vertical height in feet from the centre of the return pipe next the boiler to the centre of the flow pipe entering the radiator.

" h = the head in inches causing the flow through that part of the system represented by H.

= the increased height in inches of a column of water heated from T_3 to T_2 degrees Fahr. taking the value of H for the height of T_3.

" h_1 = the equivalent head in inches of the velocity of the water in the pipe, calculated from the actual discharge.

" v = the theoretical velocity per second of a body falling freely in space from a height h.

" v_1 = the theoretically attainable velocity per second of the water in the pipes of a hot-water gravity apparatus for a difference of 30 degrees (200 — 170) between the temperature of the main flow and return.

($V_1 = 0.74v$ approximately.)

" v_{11} = the velocity per second of the water in the pipe, calculated from the actual discharge.

" V = the velocity per second in the constricted part of a pipe.

" a = the area of the pipe in square inches.

" g = gravitational acceleration, (= 32.2).

" W = the weight of a cubic foot of water at temperature T_2.

" W_1 = the weight of a cubic foot of water at temperature T_3.

" w = number of pounds of water per minute.

" f = the friction head in inches for a given flow in a pipe 10 ft. long.

" x = the number of 10 ft. lengths of pipe. The total friction head in inches for the required flow in a pipe of x length = fx.

" C = the free or unbalanced head in inches which would cause acceleration.

" C_0 = the area in square inches of a "vena contracta" required to prevent acceleration.

" A = the available head in inches.

Eq. 1. To ascertain the heating surface required to maintain the heat in a room cooling at the rate of U heat units per hour.

$$S = \frac{U}{(T_1 - T)\,t} = \text{sq. ft. in radiator.}$$

Eq. 2. Water required in pounds per minute to compensate the heat transmitted by the radiator.

$$w = \frac{St\,(T_1 - T)}{60\,(T_2 - T_3)} = \text{lb water per minutes.}$$

Eq. 3. Theoretical velocity in feet per second of a body falling freely in space from a height h.

$$v = \sqrt{\frac{2gh}{12}}$$

This velocity is never attained in the pipes of a gravity hot-water apparatus, the flow due to the head being affected by the mass of the water moved in the system, also by frictional losses and mechanical imperfections.

The force producing motion is the difference in weight of two columns of water at the respective temperatures of T_2 and T_3 and of a height (H) and the theoretical velocity of the water in the pipes of a heating system under the stated conditions cannot exceed that given in Eq. 4.

Eq. 4. $v_1 = \sqrt{\frac{(2g)\,H\,(W_1 - W)}{W_1 + W}}$ = theoretical velocity in ft. per second neglecting friction.

For which may be substituted (for heights and temperatures usual in heating apparatus) Eq. 5.

Eq. 5. $v_1 = 0.74\sqrt{\frac{2gh}{12}}$ = velocity in feet per second.

The velocity of discharge v_{11} is obtained from Eq. 6.

Eq. 6. $v_{11} = \frac{w}{25a}$ = velocity in a pipe in feet per second.

The head (h_1) due to the velocity (v_{11}) is found by Eq. 7.

Eq. 7. $h_1 = \frac{12(v_{11})^2}{2g}$ = head in inches.

The velocity (V) of the water in the constricted part of a pipe is obtained by Eq. 8.

Eq. 8. $V = 0.74\sqrt{\left[\frac{2g(c+h_1)}{12}\right]}$ = velocity in ft. per second.

The area of the constriction (C_0) is given by Eq. 9.

Eq. 9. $C_0 = \frac{w}{25V}$ = area in square inches.

If the constriction is a hole in a thin plate take 1.4 times the area required for a "vena contracta."

This is an arbitrary allowance, as the area of the hole will be affected to some extent by its relation to the area of the pipe.

The diagram illustrates a hot-water system for a building of four floors 10 ft. high, with radiators on every floor, each containing 100 sq. ft. of heating surface, served by three sets of flow and return risers connected to horizontal mains in the basement.

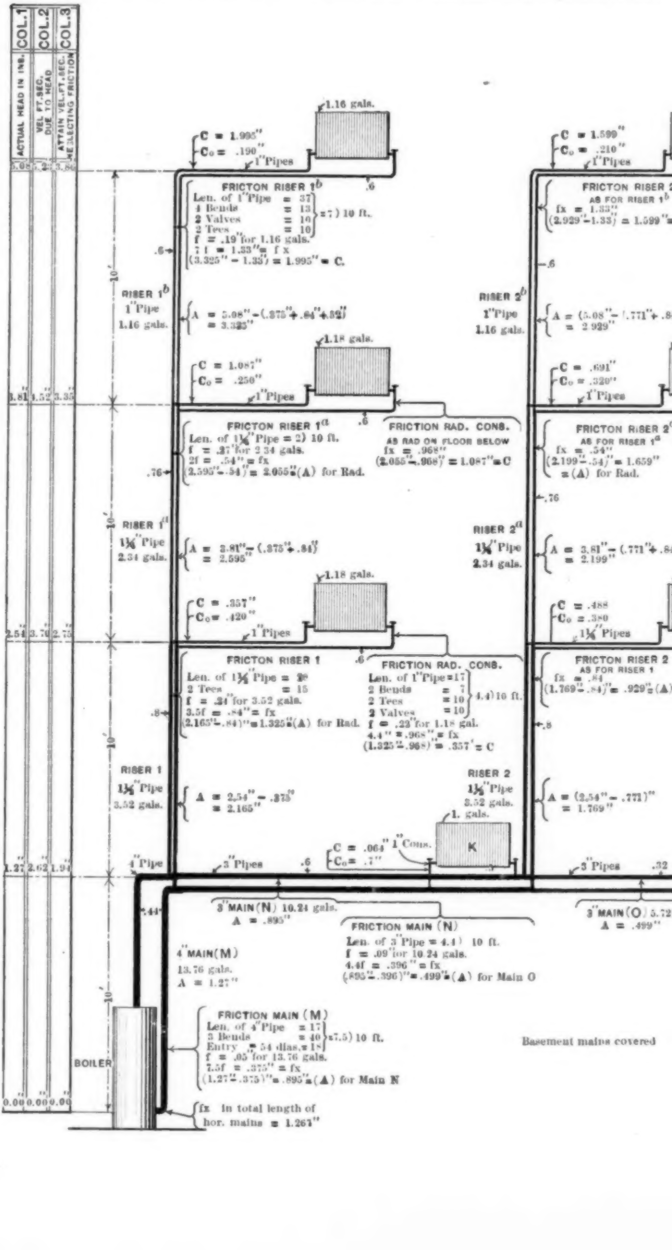
The actual head for the flow is figured for each floor in inches for a difference of temperature between the flow and return of 30 degrees, the flow being assumed at 200 degrees and the return at 170 degrees. (See Col. 1.)

Col. 2 gives the velocity per second, due to the head for each floor, attained by a body falling freely in space and is chiefly useful for comparison with the actual velocity of the water in the pipes, figured inside a circle against each pipe.

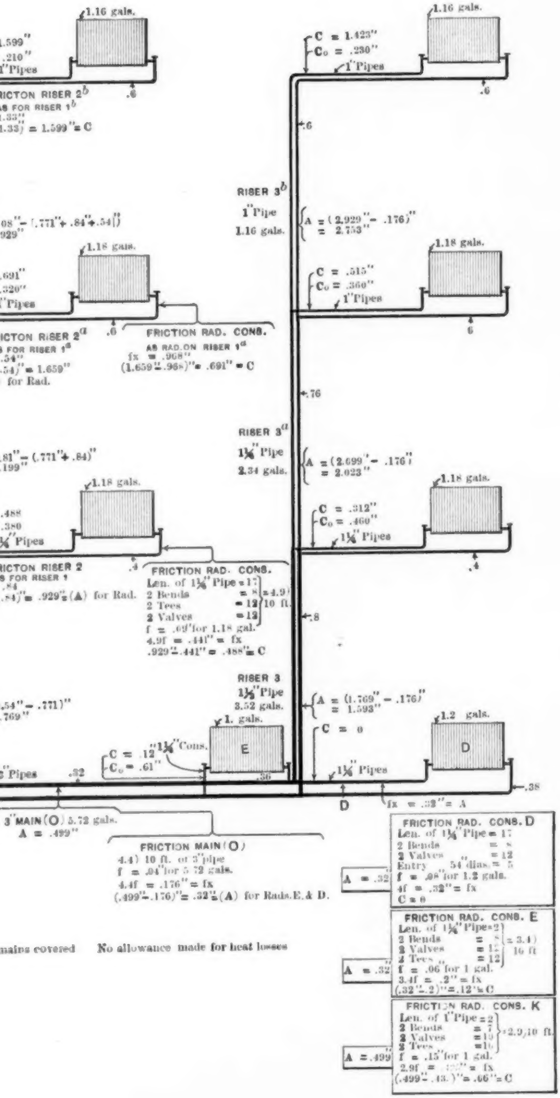
Col. 3 gives the theoretically attainable velocity per second in hot-water apparatus due to the head, neglecting frictional and other losses.

The method of procedure in working out the diagram is to ascertain by the given formula the amount of water required to pass through every portion of the system to maintain the heat of the flow at 200 degrees and that of the return of 170 degrees, beginning with the radiators at the top of the building and adding successively the duty for the floors below, figuring at the junction of the risers with the basement mains the volume in gallons to be supplied by each riser per minute. The summated volume is then noted against the flow pipe from the boiler; this represents the boiler duty, *i.e.,* that of raising the temperature

DIAGRAM ILLUSTRATING A METHOD OF ESTIMATING THE SIZES OF THE PIPES
ENCE IN TEMPERATURE OF 30 DEGREES FAHR. BETWEEN THE FLOW AND
RETURN AT 170 DEGREES. ALL RADIATORS CONTAIN 100 SQUARE FEET.



HE PIPES IN A GRAVITY HOT-WATER APPARATUS FOR A DIFFER-
OW AND RETURN, THE FLOW ASSUMED AT 200 DEGREES AND THE
E FEET.



of so many gallons of water per minute 30 degrees from 170 degrees to 200 degrees Fahr.

In the diagram this duty amounts to 13.76 gals. for which a 4-in. pipe is selected. Referring to a pipe discharge diagram, the friction head of a 4-in. pipe for this duty is found to be 0.05 in. per 10 ft. of length, and as the pipe has an equivalent length of 75 ft., including loss by entry and that for three elbows, the total friction head for the section of the main between the boiler and the first riser *M*, in diagram, is 0.375 in., which, deducted from the actual head for the ground floor (1.27 in.), leaves 0.895 in. as the available head for the next length of main *N*. This main, being relieved of the duty for riser 1, viz., 3.52 gals., has only to pass 10.24 gals., for which a 3-in. pipe is selected. The friction head for this duty in a 3-in. pipe is found by the diagram to equal 0.396 in. Deducting this from the last available head (0.895 in.) leaves 0.499 in. as the head available for the next length of main *O*. Similarly, main *O*, which retains the full diameter of 3 in., with its smaller duty leaves an available head for the 1¼-in. end connections *D* to the ground floor radiator at its extremity, of 0.32-in., which just balances the friction head for the 1¼-in. connecting pipes to the radiator.

Attention is directed here to the setting out of the basement mains which is purely arbitrary, as obviously there are several alternatives to that chosen. It might have been better to have increased the size of the main *M* to 5-in. diameter, and that of *N* and *O* to 4-in. diameter, so reducing their frictional losses sufficiently to permit of the use of smaller risers and connections under the greater head rendered available by the reduced friction in the mains. This would also have allowed of the connections to the last two radiators on the ground floor being made 1 in. in diameter instead of 1¼ in., as found sufficient for the first radiator next the boiler.

The question arises here which alternative is the more economical: to use large basement mains to maintain, as nearly as possible, a constant head throughout their length, so minimizing the sizes of the risers, or to wiredraw the mains and, in consequence, have to increase the diameter of the risers for constant duty with their distance from the boiler.

Usually it is better to adopt the former alternative where cir-

cumstances permit, but it is frequently desirable to keep the mains as small as possible to avoid disfigurement of the building. This, however, can only be done successfully when the effect on the circulations to the remoter parts of the system, resulting from the use of smaller mains, is thoroughly understood and appreciated.

Returning to the analysis of the diagram, it is found that riser 1, between the ground and first floor, has to pass 3.52 gals. per minute, for which the actual head is 2.54 in. (see Col. 1 in margin), and the available head is 2.54 in. minus the friction head for main M (0.375 in.), which leaves 2.165 in. the available head for the riser, in which the head for friction when passing 3.52 gals. per minute through an equivalent length of 35 ft. of 1½-in. pipe is found to be 0.84 in., and this deducted from 2.165 in. leaves 1.325 in. the head available for the radiator connection on the first floor.

This radiator requires 1.18 gals. per minute, and by similar procedure an inch pipe is found to be sufficient for the duty, the friction head being 0.968 in. which deducted from the available head of 1.325 in. leaves an unbalanced or free head C of 0.357 in., from which by Eqs. 8 and 9 the area is found of the constriction C_0 required in the inch pipe to prevent acceleration.

The process is repeated for the upper floors, deducting the cumulative friction head of the pipes between them and the boiler from the actual heads.

It should be noted here that the friction head for the radiator connections is not cumulative, as the riser which serves them under the head available for the floor on which the radiator is situated is capable of supplying the volume of water for the radiator plus that for the floors above, under the same head; or, in other words, a pipe will supply any number of branches within its delivery capacity under a common head.

In the diagram risers 2 and 3 are separately computed, for, although the duty for the three risers is identical, the available head at the points where the risers start from the mains decreases with the rise of the friction head in the mains, due to their increased length.

An interesting point is that the radiators on risers 2 and 3, first floor, require 1¼ in. connections for the same duty for

which an inch pipe is found ample in the case of riser 1. This is due to the lower available head in risers 2 and 3, caused by the increased friction in the mains serving them.

The calculations may be simplified by plotting curves for head and velocity, also in other ways that will occur to the engineer.

The method described is applicable to reinforced systems, either thermal or mechanical, in which a controlling device for regulating the flow is equally necessary.

The want of accurate data relating to the design of hot-water apparatus is generally acknowledged. The author has devoted much time to the subject and has demonstrated by numerous experiments, that may form the subject of a future paper, the substantial accuracy of the constriction factor herein given, concerning which little information of practical use is obtainable from text-books.

CCXI.

PERFORMANCE OF HEATING GUARANTEES.

BY WILLIAM KENT.

(Member of the Society.)

In Prof. John R. Allen's paper on "Coefficients of Transmission in Cast Iron Radiators," in the Transactions of the Society for 1908, he gives some formulas for determining to what temperature a room should be heated when the outside temperature is above zero in order to prove the performance of a guarantee that the heating apparatus will heat the room to 70° when the outside temperature is zero or other specified low temperature.

One of his formulas, applicable to a two-column cast iron radiator, is:

$$\frac{(t_3-t_2)\,[0.0036\,(t_3-t_2)+1.32]}{t_2-t_1}=\frac{(t_3-t_5)\,[0.0036\,(t_3-t_5)+1.32]}{t_5-t_4}.$$

For a three-column radiator the formula is the same except that the coefficient 0.0036 is replaced by 0.00467 and the term 1.32 by 1.14.

t_1 = temperature of the outside air for the contract condition.
t_2 = " " " room, guaranteed by the contractor.
t_3 = " " " steam in the radiator during the test.
t_4 = " " " outside air during the test.
t_5 = computed temperature of the room for the test conditions.

The unknown quantity is t_5, and its determination involves the solution of a quadratic equation. The formula is based on the assumption that the coefficient of transmission of heat through the radiator per degree of difference of temperature is not a constant, but equals a constant, 1.32, plus a fraction of the difference, 0.0036 $(t_3 - t_2)$, for a two-column radiator. The coefficient of transmission through the walls and windows is,

however, taken as a constant, $= (W/4 + G)n$, in which W is the wall surface, G the glass surface and n a factor for exposure, taken usually at about 1.20.

In the discussion of Prof. Allen's paper Mr. W. W. Macon presents a couple of tables and a method of calculation by which the temperature of the room for different outside temperatures and different temperatures of steam or hot water may be found. With each temperature of steam or hot water in the tables is given a factor by which the number of degrees that the outside temperature is above zero is to be multiplied, in order to obtain the number of degrees above 70° to which the room must be heated during the test. Mr. Macon's tables are based on the assumption that the coefficients of heat transmission per hour per degree of difference of temperature between the steam and the room, and between the room and the outside air, are both constants.

While Prof. Allen's assumption that the coefficient of heat transmission varies with the temperature difference is probably more accurate than the assumption that it is a constant, yet the error of the latter assumption is so small in any practical case of testing the performance of a guarantee of a heating plant as to be of no importance. The usual guarantee is to heat the room to 70° in zero weather. If the temperature of the steam is, say, 220° and the outside temperature 40°, the room may have to be heated to something under 100° to equal the 70° — 0° guarantee, making a temperature difference between the steam and the room of 220 — 100 = 120 instead of 220 — 70 = 150, and the temperature difference between the room and the outside air 100 — 40 = 60 instead of 70 — 0 = 70. Taking Prof. Allen's value of the coefficient for a two-column radiator, $1.32 + 0.0036 (t_3 - t_2)$, for 120° difference it is 1.75, and for 150° difference, 1.86. The difference between these figures is less than the accidental difference between two radiators of the same size subjected to test under slightly varying conditions.

More than fifteen years ago the author published in *Engineering Record* (August 11, 1894) the formula given below for determining to what temperature the rooms should be heated with various temperatures of the outside atmosphere and of the steam or hot water in the radiators.

Let S = sq. ft. of surface of the steam or hot-water radiator;
W = sq. ft. of surface of exposed walls, windows, etc.;
T_s = temperature of the steam or hot water, T_1 = temperature of inside of building or room, T_0 = temperature of outside of building or room;
a = heat-units transmitted per sq. ft. of surface of radiator per hour per degree of difference of temperature;
b = average heat-units transmitted per sq. ft. of walls per hour per degree of difference of temperature, including allowance for ventilation.

It is assumed that within the range of temperatures considered Newton's law of cooling holds good, viz., that it is proportional to the difference of temperature between the two sides of the radiating-surface.

Then $aS\,(T_s - T_1) = bW\,(T_1 - T_0)$. Let $\dfrac{bW}{aS} = C$; then

$$T_s - T_1 = C\ (T_1 - T_0);\ T_1 = \frac{T_s + CT_0}{1 + C};\ C = \frac{T_s - T_1}{T_1 - T_0}.$$

If $T_1 = 70$, and $T_0 = 0$, $C = \dfrac{T_s - 70}{70}$.

The formula as given above was also published in the author's "Mechanical Engineer's Pocketbook" (7th edition, page 546), and the following calculations have since been made:

Let T_s =	140°	160°	180°	200°	212°	220°	250°	300°
Then C =	1	1.286	1.571	1.857	2.029	2.143	2.571	3.286

and from the formula $T_1 = (T_s + CT_0) \div (1 + C)$ we find the inside temperatures corresponding to the given values of T_s and T_0 which should be produced by an apparatus capable of heating the building to 70° in zero weather.

Inside Temperatures T_1.

T_s \ For T_0 =	− 20	− 10	0	10	20	30	40° F.
140° F.	60	65	70	75	80	85	90
160	58.7	64.3	70	75.6	81.3	86.9	92.5
180	57.8	63.9	70	76.1	82.2	88.4	94.5
200	57.0	63.5	70	76.5	83.0	89.5	96.0
212	56.6	63.3	70	76.7	83.4	90.1	96.8
220	56.4	63.2	70	76.8	83.6	90.5	97.3
250	55.6	62.8	70	77.2	84.4	91.6	98.8
300	54.7	62.4	70	77.7	85.3	93.0	100.7

In Prof. Allen's paper the following results are given of the case of steam heating with steam at 227° F. (5 lbs. pressure).

Outside temperatures... ...	−20°	−10°	0°	10°	20°	30°	40°
			Room Temperatures.				
2-col. radiator...............	58	64	70	77.5	83	90	97
3-col. radiator............ ..	59	64	70	75	83	89	95
The author's formula gives.	56.2	63.1	70	76.9	83.8	90.8	97.7

For temperatures from —10° to 40° the author's results are within one degree of those of Prof. Allen with the two-column radiator. Results obtained by Mr. Macon's method of calculation are identical with those obtained by the author's formula.

It is submitted that on account of the simplicity of the author's formula, and its practical correctness in the light of our present knowledge of heat transmission, together with the convenience of the above table, they should be generally adopted by heating engineers and used in making guarantees. The following is suggested as a brief form to be used in specifications:

"It is agreed that when it is not convenient to the contractor to wait for an outside temperature of zero Fahrenheit (or other stated low temperature) in order to make a test of the heating plant, then a test may be made at any time when the temperature is not above 40°, and the rooms must then be maintained at a temperature found from the following formula:

$$T_1 = \frac{T_s - CT_0}{1 + C}; \quad C = \frac{t_s - t_1}{t_1 - t_0};$$

in which T_1 is the temperature to be maintained in the rooms, T_s the temperature of the steam or hot water in the radiators or coils, and T_0 the temperature out of doors during the test, and t_1, t_s, and t_0 the corresponding temperatures named in the guarantee."

In addition to the table given above, the following factors may be used by which to multiply the degrees of difference between zero and the outside temperature at the time of the test, in order to find the number of degrees above 70 degrees, at which the room temperature is to be maintained, the guarantee being 70 degrees at zero weather:

Temp. of steam or water..	140	150	160	170	180	190	200	210	250
Factor...........	0.500	0.533	0.563	0.588	0.613	0.633	0.650	0.668	0.720

Steam, gauge pressure	0	1	2	3	4	5	6	8	10
" temperature.......	212	215.3	218.5	221.5	224.4	227 2	229.8	234.8	239.4
Factor....................	0.670	0.675	0.680	0.684	0.688	0.691	0.695	0.702	0.708

DISCUSSION.

Professor Hoffman: I would like to comment a word or two on the comparison between the table that Professor Kent gives

on page 3, and the table worked out by the Committee on Tests at this meeting. I have in two or three cases tried the values through and in no given case have I found anything more than about 0.2 or 0.3 of one degree difference between Professor Kent's table and the one that the committee have turned in in their report.

Mr. Collamore: It seems to me that some statement should be made in reference to wind conditions. I assume that the guarantee is based on still air. You take a designed radiator for a room of a northwest exposure and if on the day of test you have a condition of no wind, you probably will get better results than if you had a prevailing northwest wind. It seems to me some statement should be made with reference to wind conditions.

Mr. Bushnell: One question I would like to ask Professor Kent, whether he has considered, in adopting this guarantee, anything in regard to the time taken to attain a certain temperature. We all know there is a very great difference in construction. Some buildings of heavy construction might take some time to heat up, and those of light construction heat up very readily, and whether it is advisable to put in that the test be delayed a certain number of hours to attain such a temperature.

Professor Kent: In answer to both these questions, whether it would not be well to put in something about the effect of wind, and also the other, the effect of the time taken in the test, I would say that the object of this calculation was merely to find a temperature at which the room should be maintained instead of 70 degrees when you could not get zero temperature outdoors. Now, if there are any contracts made which have specifications in regarding the time and regarding the wind, these equations would hold just the same. I do not intend to go into the question of how much allowance should be made for different conditions of wind or how much time should be taken to make the test, because these are outside of the thing that I was after, which was merely to get a temperature at which the room should be maintained to meet the guarantee. Now if the guarantee says nothing about wind or about the time, it may be a matter of controversy or agreement between the parties as to how these conditions of wind and time should be met.

Speaking further on the question of time, I should think that, instead of saying that the test should be made after six or seven hours of heating, it ought to be made after three or four days; that is, if the house is finished in October or November, and the workmen do not care about having the house heated in order to finish the plastering, and if the plastering and walls are wet, during an outside storm, and then you put on the heating plant, it would probably take at least a week before that building would be in anything like running condition. If you are going to put in a condition of time you will have to put in all these contingencies about the plastering and all that, because it will take a long time to get the building into running condition.

In regard to the effect of wind, we cannot say much about that until we have some tests on the question of the effect of wind, and I think it is entirely premature to introduce that feature, except to say that the test should not be made when the wind was at thirty miles an hour, or some other actual figure, but should be made in normal conditions of wind.

Mr. McCann: Speaking as a buyer of a heating plant: if I buy a heating plant under a guarantee I expect the house to be heated to a comfortable degree, notwithstanding that there may be a gale howling outside with the wind blowing at sixty miles an hour; and a test made under mild conditions of 20 or 30 degrees temperature and little or no wind would not assure me by any means that I would have the house heated under the other conditions which would be mentioned in the guarantee.

Mr. Kimball: In designing systems ordinarily we take into account the conditions we are apt to get; that is, we take the maximum conditions, and we have got to provide against wind conditions and everything else. I do not see why, in taking the test of high temperature, we should not assume that the wind conditions, too, may be just what we are apt to get. I do not believe we know enough about it now to make any very definite statements applying to wind conditions. We have got to take it just as we find it, just as we do zero conditions.

Mr. Bushnell: A temperature of 70 degrees in zero weather is an artificial matter. In some parts of the country it is very seldom that zero weather is ever met, though in other parts it

is often that we have two or three weeks of it in the winter. Under those circumstances it would make a decided difference whether a man could run in zero weather for the seven or eight days that he might have to contend with it. I do not see that under the general circumstances anything very definite can be said on the subject.

Mr. Quay: Some of our members have made quite exhaustive tests on this question of velocity of wind, which have not been published in our proceedings, and it is a very important question to any one who has investigated the matter or tested a plant or guaranteed a plant, who knows that the effect of air leakage around windows and other places affects the heating guarantee and the amount of radiation required very much. It seems to me it might be well, as long as the matter is in embryo, partially, at least, to have a committee appointed to take up this question of air leakage and velocities in connection with the guarantee of heating systems.

CCXII.

VARIABILITY OF INTERIOR CONDITIONS IN SCHOOL ROOMS.

BY H. W. WHITTEN.

(Member of the Society.)

The figures contained in this paper are taken from inspectors' reports on Massachusetts school buildings, compiled by Joseph A. Moore, Deputy Chief, Massachusetts District Police, and show the remarkable differences in interior conditions with apparently similar volumes of supply and degrees of temperature. These tests were made at various times during the past eight years, and Mr. Moore states that they are a fair average of conditions found by the inspectors of his department.

It will be noted that in many cases the outlet volume is twice that of the inlet, while in others the reverse is the case. The effect of this variation on room temperatures is, however, not consistent. In some cases the temperature of the room is higher than that of the air supplied at the inlet, while the volume of outlet air is very much greater than the supply. In cases of this type Mr. Moore says the other rooms in the building were being robbed.

He further says that nearly all the apparent inconsistencies were on account of outside winds causing in or out leakage through outer openings.

These tests were made before any attempt was made to correct the discrepancies.

This information is obtained through the courtesy of the Governor of Massachusetts, no buildings being named, as the data are not a public record.

OUTLET			INLET		
Temperature Outside.	Volume Cu. Ft. per Minute.	Temperature at Grill.	Volume Cu. Ft. per Minute.	Temperature at Inlet.	Temperature of Room.
5.5	2,996	68	1,864	115	52
12	3,003	76	2,229	95	77
13	1,593	67	1,589	110	58
13	1,578	80	1,458	120	62
13	2,475	74	2,508	112	53
13	2,320	76	2,708	120	59
14	2,480	72	2,054	95	67
14	2,804	67	2,250	110	66
14	2,981	71	2,194	110	69
14	2,724	72	1,914	88	70
15	1,305	69	1,457	110	67
16	5,860	70	3,122	75	60
16	2,207	62	2,938	72	64
17	2,700	66	1,599	80	65
18	2,806	71	2,079	109	71
19	2,833	80	1,877	108	71
19	2,945	76	1,596	100	70
19	5,464	77	3,914	102	75
19	1,215	72	2,040	96	69
19	1,927	62	1,336	84	60
20	2,390	72	1,506	92	74
23	1,665	65	1,173	93	65
23	2,461	70	1,948	90	65
24	3,162	75	2,329	98	74
24	2,848	76	2,417	81	75
24	4,603	70	3,647	83	71
24	2,517	68.5	2,735	77	69
24	2,636	71.5	1,931	84	70
24	4,239	66	3,308	73	67
25	1,868	77	1,070	120	74
25	1,371	73	1,224	124	73
27	2,283	76	1,540	96	72
27	2,336	72	2,172	95	70
27.5	2,375	84	2,461	120	79
27.5	1,710	76	1,800	85	74
28	2,009	70	1,793	70	70
28	3,950	72	3,612	75	68
28	1,888	71	1,727	80	70
28	1,515	74	1,535	84	71
28.5	1,188	69	1,039	91	73
29	2,740	68.5	1,812	80	68
29	6,330	69.5	2,172	80	68
29	2,924	69	1,670	74.5	66
29	2,899	70	1,779	80	67
29	2,276	68	1,445	70	69
29	4,503	61	1,685	58.5	62
31	1,820	72	1,600	68	72
31	1,685	72	1,630	79	71
31	1,817	69	1,281	66	69
31	1,628	69	1,320	75	67
31	1,568	66	1,388	77	66
31	2,043	69.5	2,000	76	67
32	1,938	68	2,092	77	68
32	2,242	69	2,115	74	69
32	1,369	68	1,173	65	68
32.5	2,480	74	2,330	90	70
33	1,200	75	2,236	114	75
33	1,360	73	1,573	92	71
34	1,874	72	1,314	81	70
34	1,092	70	1,081	90	67
34	3,743	74	1,752	85	70
35	1,709	71	1,230	77	68
35	1,848	74.5	1,311	85	71
36	2,650	74	1,269	86	69
36	3,218	67	1,570	90	64
36	2,251	72	1,176	97	66
36	2,665	70	1,459	90	63
37	1,904	70	1,573	80	68
37	1,825	69	1,565	85	69
37	1,958	74	1,298	81	70
37	1,659	70	1,142	87	67
37	1,991	60	1,784	60	64
38	2,551	67	1,233	95	67
38	2,483	79	1,728	85	71
38	2,709	69	1,807	76	66

OUTLET			INLET		
Temperature Outside.	Volume Cu. Ft. per Minute.	Temperature at Grill.	Volume Cu. Ft. per Minute.	Temperature at Inlet.	Temperature of Room.
38	2,350	72	1,613	94	67
38	2,347	72	1,246	80	68
39	1,738	67	1,458	70	69
39	1,610	70	1,404	56	72.5
39	1,634	65.5	1,191	78	68
40	2,003	73	1,009	100	65
40	2,515	72	2,185	92	66
40	2,235	70	1,434	82	66
40	1,707	67	926	75	64
40	2,095	69	1,269	85	65
40	1,064	65	1,443	77	65
41	1,722	72	1,105	93	69
41	1,734	75	1,491	90	73
42	1,635	76	1,865	87	76
43.5	3,300	74	1,943	66	75
44	2,779	76	1,760	90	71
44	2,411	72	1,772	78	71
44	1,309	75	1,932	90	73
44	1,290	75	1,314	92	70
44	3,085	68	1,975	73	66
44	2,178	68	1,297	60	68
44	1,709	71	1,361	70	72
44	2,862	69	1,913	70	68.5
44	1,894	72	1,067	77	70
46	1,599	65	1,516	70	65
46	1,225	70	1,499	79	67

DISCUSSION.

Mr. Whitten: I will state that my object in bringing these data before the Society is to show that it is practically impossible to tell beforehand what a heating plant is going to do. In many cases there is a high degree of temperature at the inlet and low temperature at the outlet, and vice versa. Mr. Moore has since told me, after he gave me these figures, that the temperatures given here were determined by taking the temperatures at eight points in various places through the room slightly above the top of the desks. The figures are presented for your consideration and study, but I confess myself unable to deduce anything from them.

President Snow: The irregularity of these figures is certainly striking. The matter is now open for discussion. Mr. Whitten says nothing is proven, it only illustrates a remarkable set of conditions.

Mr. Barron: There is a paragraph there that I would like the gentleman to give us his concept of, or the conclusion he draws from it: "It will be noted that in many cases the outlet volume is twice that of the inlet, while in others the reverse is the case.

The effect of this variation on room temperatures is, however, not consistent." I would like if Mr. Whitten will give us his concept of just what that paragraph means. It is a little ambiguous.

Mr. Whitten: That would necessitate going through the column of figures, which is rather long and tiresome; but if we will take, for instance, the second one, where the temperature outside is 12, the supply is 2,229, and the volume of the outlet is 3,003; the temperature at the grill being 76, the temperature at the inlet 95, and the temperature of the room 77. Now we take the very next room, or the very next test, 13 degrees outside, 1,589 delivered, 1,593 at the vent, 110 at the inlet, and only 58 in the room. That is what I meant when I said in that paragraph that the figures were not consistent. You will find similar contrasts all the way through the column.

Mr. Macon: I think it would add very much to the value of the table if it were possible to include with the figures the cubic space of the room and the area of the exposed wall surfaces.

Mr. Whitten: There is no question, Mr. Macon, but what that would be so. That was impossible for me to get. I am informed that in a general way the figures that run from 1,500 to 2,000 were typical school rooms; that is, those designed to accommodate about fifty scholars. Those that ran up into larger figures were assembly rooms, from 4,000 feet up. I could not get any further definite information in regard to that, because, as I say, this is not a copy of a public record, and I was not allowed to see the plans of any of those rooms. We can assume that all of the school rooms that run anywhere from 1,500 to 2,000 are average school rooms under average conditions.

Mr. de Joannis: I would like to ask Mr. Whitten if these temperatures were taken with children in the rooms or without?

Mr. Whitten: With children in the rooms.

Mr. de Joannis: And, furthermore, at what particular time of the session?

Mr. Whitten: Usually at ten o'clock in the morning, so I am informed.

Professor Hoffman: Is this volume mentioned the volume of the room or the amount of air entering per minute?

Mr. Whitten: Volume of cubic feet of air going in.

Professor Hoffman: And are the rooms the same size or different sizes?

Mr. Whitten: With the exception of some larger rooms that take five or six thousand feet for supply or delivery, those being assembly rooms, they are the usual Massachusetts school room, which accommodates 50 to 55 scholars, about 30 x 32, with a 12-foot ceiling.

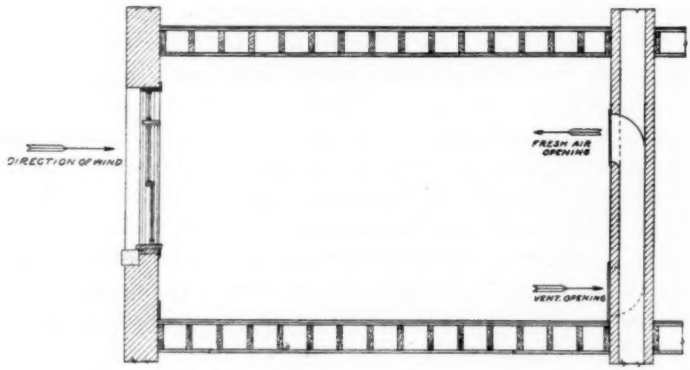
Professor Hoffman: If rooms 12 and 13, for example, are the same size, you can see why the temperature of one is 58 and the other is 77. Because you are putting less air into the room the temperature would naturally drop. If, however, room 13, having 1,589 cubic feet per minute, were a larger room and you were having the same ranges of temperature, then the results are very erratic. I think it very likely that these results would be found consistent if we only knew all the conditions.

Mr. Whitten: All the rooms from 2,000 down to 1,000 are the typical school rooms. The third one, No. 13, is practically the same room as the second room mentioned here. Mr. Moore was unfortunate in that he did not take any records of outside wind velocities or their directions at the time these tests were made. They only made interior tests and they found all sorts of erratic conditions. There is a case where the temperature outside is marked 43.5, and where 1,743 cubic feet are being delivered at a temperature of 66, but they have a temperature at the grill of 74, and the average temperature of the room is 75.

Mr. Myrick: Isn't it a matter of fact that in some of these tests of the three-story buildings, where the doors of the school rooms open, there was a lot of inside suction up through the building, and in other cases there was window play and outside conditions which affected this condition that we are speaking about? Didn't those conditions exist?

Mr. Lewis: One time, when I was in consultation advocating a double-fan system, as opposed to what is known as the Dixon system, which is an indirect system with coils at the base of the flues, and very large vent flues, we tested a plenum blast job in which we found that we could get about half the air that we wanted out through the vent openings, although plenty of air was registered at the supply openings. The balance went out through the walls and ceiling and cracks. Then we tested the

gravity indirect job, and we found fully twice as much air going out through the vent flues as we were putting in through the supply openings. They claimed then that the indirect gravity job gave better ventilation than the plenum fan system, which just shows the point, I think, that we need to consider. For instance, I understand the new Vermont law calls for the removal from the rooms through the vent flue of as much air as is admitted through the supply flue. I do not believe it is possible to accomplish that at all, except with the double-fan system, perhaps. I think that we are getting ventilation when we deliver 30 cubic feet of air per person per minute, whether or not we



SECTION THROUGH SCHOOL ROOM

get that all out through the vent outlet. Some of that air that has been breathed goes out through the walls or ceiling, but still it is accomplishing ventilation.

Mr. Collamore: I have made a rough sketch on the blackboard which I believe will illustrate the idea of Mr. Whitten's paper. This is intended to be a section of a school room. In Mr. Whitten's table in some cases he records a greater amount of air leaving the room than that entering the room. I take it the idea is that with the wind pressure against the glass surface of an outside wall, that if the windows are not tight there will be a leakage of air into the room. I have not made experiments to prove this statement, but I take it that this would create a zone in the room along the outside wall in which the air is

cooler than on the inner wall of the room, and would, perhaps, affect the circulation of the air in the room in this manner, that the air would not always reach the opposite surface of the room, and with the leakage of air not heated added to the air delivered through the air inlet, it is possible in a school room to have more air taken out of the vent flue than enters the room by the air inlet. Conversely, confirming what Mr. Lewis has said, if there is no decided wind acting on the building, it is possible for the air to leak out through the windows, in which case—and this is the ordinary case that most experiments will show—there will be less air taken out of the room through the vent flue than enters the room through the air inlet. Furthermore, the effect on room ventilation is such as to decrease its effectiveness, because, even if the requisite amount of air is delivered into the room, through the air inlet, which is nominally stated to be 30 cubic feet of air per pupil, it is true that a large amount of the air will leave the room above the breathing plane. I believe this brief description explains to some extent the erratic results obtained by Mr. Whitten.

President Snow: Mr. Whitten will perhaps explain a little more fully how the tests are conducted by the Massachusetts inspector, measuring preferably at the vent outlet, as I understand. It may not be clear to all the members why the table is arranged with the vent outlet first.

Mr. Whitten: The rule laid down by the late Rufus Wade for measuring inlets and outlets was practically this: assuming this to be the inlet (illustrating on the blackboard), as most inlets are found to have somewhat of a dead air space across the bottom, no tests being taken there, the anemometer readings are taken at several points, and the average reading taken; the outlets near the floor are measured in the same way, with the exception that the dead air space is then at the top. It is usually found to be so.

Another test which they have used extensively is with the thistle-down of fox fennel, which is very light indeed, and will float for a long time, even better than tobacco smoke, and that is put in front of this inlet and its course observed. More of it is let loose in front of the windows. It has been found in many cases that that let loose in front of the windows will fall, go

across the room, rise a little bit, fall, catch or go on out of the window.

President Snow: Mr. Whitten, will you make clear whether that dead space in the register which is omitted is fixed arbitrarily or determined by the anemometer each time?

Mr. Whitten: It is determined by an anemometer each time. In other words, it will be found in most cases, unless, as has been adopted comparatively recently, the inlet had been divided by deflectors. In that case you get some action here. Unless that is done, if you have the ordinary inlet, the air coming up forms an eddy. The greater the current the stronger this eddy and the less direct outflow there is. I have seen, in a 1,200-foot velocity, the actual output cut down far below what could be gotten out of a 300-foot velocity for that very reason.

President Snow: Will Mr. Whitten explain, please, whether the 30 cubic feet per minute per pupil is determined at the ventilating outlet or otherwise?

Mr. Whitten: That is measured at the outlet. That is what Massachusetts testing compels. It doesn't matter what comes in. Frequently they find that with a delivery of the legal amount they do not get in some cases three-eighths of the supply at the vent. In other cases it is augmented.

Mr. Lewis: It seems to me that the point at which that is measured is a very vital consideration, and one that affects the subject of ventilation in schools very seriously. I have never been educated on the subject of measuring the vents, but I think that it ought to be established on one point or the other.

Mr. Cary: After determining by anemometers the velocity of the inrushing air, what area is taken in order to determine the volume? What part of the area is defined as a dead space? Is that included in the calculation?

Mr. Whitten: It is not.

Mr. Cary: Well, it is a pretty difficult thing to define exactly where the line should be drawn in order to get the true area of issuing air at the average velocity. And the use of an anemometer in a pipe gives us less information than we are apt to think. The anemometer is made to be used in the outside air, where there are no counter-currents or frictional currents existing outside of the anemometer shell. I had occasion to test

the flow of air in a gas producer, and I tried to use the anemometer to get some information, and after determining more correctly by other means I found that the anemometer gave me more misinformation than it did information.

Mr. Myrick: I would like to make a motion that the incoming president be requested to appoint a committee to determine whether that test should be made at the inlet or outlet. This subject is being agitated, and other States are following the lead of Massachusetts. No doubt a difference between the temperature coming in at 98 and possibly 67 at the outlet would account to some extent for the great diminution in the volume of air; 1,500 cubic feet of air per minute, there would be somewhat less going out, of course, at the lower temperature. Now, in the Vermont law, it is said they shall put in and remove that amount. Now, if they are going to put in 30 cubic feet of air per minute they are going to remove a little less, naturally. The difference in temperature will take some of that.

President Snow: I would state that that question can very properly be referred to the Standing Committee on Tests.

Mr. Myrick: Well, I would like to make a motion that it be referred to that committee.

Motion put and carried.

Mr. Lewis: I have never been able in testing to satisfy myself that there was any advantage in putting in curved deflectors in the flue outlet, endeavoring thus to make the air coming into the room have a uniform velocity over the entire area of the opening. Air is so elastic, in my opinion, that once get, say, 1,500 cubic feet per minute started coming up a flue, no matter whether the outlet be restricted a little on account of the eddy caused by the square outlet, it is compelled to spread around in the room, and you cannot tell any difference in the room whether these deflectors are in place or not, and, on the contrary, my experience indicates that a high inlet velocity with horizontal diffusers, is desirable.

Mr. Collamore: I would like to make another picture on the board to show why it is desirable to have deflectors, although they are not very effective. If you plot the velocities of air being delivered to the heat opening you will get a line something like that (illustrating on blackboard), in which these are the entrance

velocities, these are the negative velocities, and these are the positive velocities. The effect is to increase the average velocity of air being delivered, and if you have had any experience with teachers in school rooms you will appreciate the fact that they object very seriously to what they call drafts. By putting deflector plates into the openings, although you do not gain ideal conditions, at the same time you get a lower average velocity; in other words, the effect of the air delivered is not so noticeable. Taking the average air velocity for the whole room at 350 feet per minute, it might be as high as 450 feet at the upper part of the outlet; whereas by putting in deflector plates you cut the maximum velocity down to 400 feet per minute.

Mr. Lewis: When they have complained of drafts I have generally increased the temperature of the entering air and thus avoided them.

Professor Hoffman: I understand the diffuser is largely to cut off drafts, so a person will not feel the onrush of the heated current of air. A deflector in the duct itself will not accomplish this object so well.

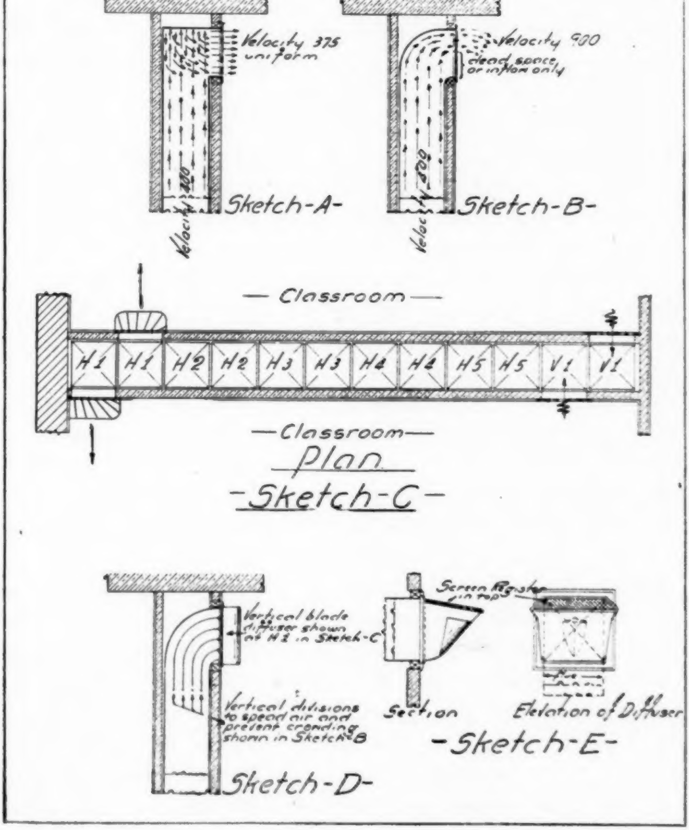
President Snow: The diffuser you refer to is made of vertical plates?

Professor Hoffman: Yes; and is set on the register face outside the duct.

Mr. Whitten: The point I make in regard to this was brought to me some years ago by Mr. Edgar Hannaford of Cincinnati, who has had some experience in this line. (The speaker illustrates on the blackboard.) Some one had put in a flue with a dead corner here and the air came up here and choked off what otherwise might have escaped. Of course that was remedied by putting in a round corner or elbow. That helped, but he got an idea that even this was an approximation to an angular elbow. It was the best that he could do, because he had to change the direction of the air. He took careful measurements of his delivery. His argument was that he could prevent the choking caused by the eddy in the corner by means of his round turn, and in order to prevent the air which was driven up here by its acceleration choking what might be coming up here and going across, he put in these partitions simply to prevent this upward current from interfering with the change

to horizontal. Of course there was some friction all around. But with all that, after he had summed it up, Mr. Hannaford's summary was that he got about 15 per cent. more delivery from this than he did with the deflector not in.

Mr. McCann: We have used square elbows at the tops of



the outer curve, and will thus get a circular motion and a heat uptake with better results than obtainable with round elbows at this point, the reason being, in my judgment, this: (speaker illustrates on the blackboard) that with a square

elbow, as shown in sketch A, we get a mixing and a breaking up of currents of the air in the corner, and the air will, therefore, spread out from all parts of the register opening fairly evenly; but with a round corner, i. e., with the head rounded off, as shown in sketch B, the air will crowd together along high velocity that will bring it right around and down onto the head of the teacher.

Mr. Whitten: That is what your deflector is to prevent.

Mr. McCann: The deflector will prevent that difficulty, but if you are going to leave the deflectors out of the vertical flue you had better have the elbow square.

Mr. Feldman: It is quite customary to have the outer box a great deal wider than the duct. (Speaker illustrates on the blackboard.) I have tested some of those boxes and found that no air was coming out at the outer points. I remedied that by putting in diffusers.

To distribute the air more evenly these diffusers should be carried out in front of the register openings. In this way the outlet area may be increased, and therefore a lower velocity obtained on the outside.

Mr. McCann: It is necessary to overcome the effect of crowding the air together. If the vertical division plates or deflectors are put in the vertical flue, it is also necessary to put a diffuser on the front of the register, of a form which will divide the air and spread it, the form depending, of course, upon the location of the register in the room.

Taking a room, with a breathing wall, so-called, across one end, we may have four or five or more flues in this wall. See sketch C. With the first story register located in one corner it will be necessary to put in a diffuser which will throw part of the air toward the far corners of the room. Of course each location of flue, for the second or third or fourth story, etc., will require a different shape of diffuser. These diffusers, if of the usual vertical straight blade type, will not at all affect the crowding of air in the vertical flues, and will not therefore render unnecessary the division plates inside the flue. Both will be needed to get good results. See sketch D.

We obtain practically the same results by putting a special form of diffuser on the outside of the register with square-

head flues. These diffusers are made like sketch E. The faces or sides are shaped to suit the location. For instance, in the location of H_3 in sketch C, the diffuser would be as shown in sketch E, with rolled edges and formed to spread equally both ways, so that the air will be uniformly scattered. In the corner one side would be square and the other side would be brought quite a distance over, and the diffuser would thus be arranged so that the air would be scattered mostly to one side. The shape of the diffuser must always be determined by the location of the inlet in the room, and so as to give uniform distribution sideways. The effect of the crowding of the air at the head of the flue behind the register is overcome by this arrangement of the surfaces of the room diffusers and the air is scattered evenly over the ceiling.

CCXIII

REPORT OF JOINT COMMITTEE CONSISTING OF THE MEMBERS OF THE COMMITTEE ON STANDARDS AND THE COMMITTEE ON HOUSE-HEATING BOILERS.

GENTLEMEN:

Your Committee, consisting of the members of the Committee on Standards and the Committee on House-Heating Boilers, together with President Snow, who is ex-officio a member of the Committee, has continued its work in connection with which it submitted in July a preliminary report. As a result of its labors, the Committee presents herewith, in Table I., a rating of Cast-iron House-heating Boilers, based upon the area of grate surface and the coal burned per hour per square foot of grate surface.

In compiling the table, your Committee has considered:

1. That the area of the grate shall be the area of the opening in which the grate is placed, measured to the outermost limits of air openings.

2. That the boiler is to be used under average working conditions, carrying steam at 2 pounds pressure; that the draft shall be sufficient to burn the number of pounds of coal per hour given in the table, and that the coal used shall be a good quality of anthracite coal having a heating power of 13,000 B. T. U. per pound of dry coal.

3. That the rating as given in the table means the number of square feet of direct radiation steam surface that can be carried by the boiler, based upon the supposition that each square foot of direct radiation steam surface emits 250 B. T. U. per hour with steam at two pounds pressure in the radiator

and with air surrounding the radiator at a temperature of 70 degrees.

RATING OF HOUSE-HEATING BOILERS

Area of Grate.	Coal Burned per Hour per Sq. Ft. of Grate.	Total Coal Burned per Hour.	Rating of Boiler. Sq. ft. Radiation.
Sq. Ft.	*Lbs.*	*Lbs.*	
1	2.67	2.67	82
1.5	2.96	4.44	140
2	3.59	7.18	226
3	4.21	12.63	390
4	4.55	18.20	585
5	4.88	24.40	780
6	5.06	30.36	975
7	5.24	36.68	1,165
8	5.36	42.88	1,405
9	5.48	49.32	1,650
10	5.60	56.00	1,890
11	5.71	62.81	2,125
12	5.82	69.84	2,360
13	5.93	77.09	2,595
14	6.08	85.12	2,915
15	6.23	93.45	3,235
16	6.35	101.60	3,485
17	6.46	109.82	3,730
18	6.51	117.18	4,010
19	6.55	124.45	4,285
20	6.58	131.60	4,545
21	6.61	138.81	4,800

This table is the result of a careful study of the whole question of house-heating boilers, and your Committee recommends that it be adopted and used by the members of the American Society of Heating and Ventilating Engineers as giving the standard ratings of cast-iron house-heating boilers.

Your Committee recommends that a committee to be known as the Committee on Boiler Ratings be appointed yearly by this Society to act alone or, preferably, in conjunction with similar committees appointed by other societies or associations, to consider all questions that may arise in connection with boiler ratings, and especially those questions arising from improper or insufficient ratings of boilers. If a manufacturer of boilers shall consider that his boiler is entitled to a rating higher than the standard rating, and shall take the matter up with the Committee on Boiler Ratings, and shall submit to it the results of tests made as hereinafter provided, the Committee shall consider the matter and shall report its conclusions to the manufacturer of said boiler, and also to the Society at its next regular meeting.

Your Committee recommends that when a house-heating boiler is tested to determine its rating the method of testing

shall conform as nearly as possible to the "standard" method of testing boilers prescribed by the American Society of Mechanical Engineers, with some slight modifications, as follows:

The test is to be started by building a wood fire, raising steam, and keeping the boiler under working conditions for at least one hour. Then the fire is to be drawn and a new one made, and coal is to be added as rapidly as possible until, approximately, 50 pounds of coal per square foot of grate surface has been added. In small-sized boilers the firing interval should, preferably, be about eight hours; in medium-sized boilers, about 6 hours; and in large boilers, about 4 hours.

The steam pressure shall be maintained as nearly as possible constant during the test; and the weight of steam made shall be determined either by weighing the water fed to the boiler or, preferably, by condensing the steam as it comes from the boiler, but in all cases the amount of moisture carried by the steam must be determined and correction be made therefor; and the feed water shall, where possible, be supplied to the boiler hot.

The coal used shall be a good quality of anthracite coal, having as nearly as possible a heating power of 13,000 B. T. U. per pound of dry coal; and the rate of combustion shall be nearly as possible as given in Table I. of this report.

Just before closing the test the ash pit shall be cleaned, and at the end of the test the grate shall be dumped; and the difference between the weight of carbon in one pound of the ash during the test and the weight of carbon in one pound of the ash and coal obtained when the grate is dumped at the end of the test shall be taken as the weight of combustible per pound of ash and coal left on the grate at the end of the test.

No test shall be for a shorter period than eight hours; and observations of temperatures, pressures, etc., shall be made at intervals of at least one-half hour.

The following items should be determined by a test:

1. Date of test.
2. Duration of test.
3. Time of starting the fire.
4. Time of commencing the test.

5. The number of times fired.
6. Interval between firings.
7. Square feet of grate surface.
8. Square feet of fire surface.
9. Square feet of flue surface.
10. Total heating surface.
11. Kind of fuel used.
12. Analysis of the fuel. (Fixed carbon, volatile matter, and ash.)
13. Total weight of fuel fired.
14. Total weight of fuel left on the grates.
15. Total weight of fuel burned during the test.
16. Total weight of fuel burned during the test per hour.
17. Total weight of fuel burned during the test per hour per square foot of grate.
18. Total weight of ash and clinker.
19. Temperature of gas leaving the boiler.
20. Temperature of steam leaving the boiler.
21. Temperature of feed water entering the boiler.
22. Temperature of the boiler room.
23. Chimney draft—inches of water.
24. Pounds of water evaporated during test.
25. Pounds of water evaporated from and at 212 degrees.
26. Pounds of water evaporated per pound of fuel as fired.
27. Pounds of water evaporated per pound of dry coal.
28. Pounds of water evaporated per pound of combustible.
29. Pounds of water evaporated per square foot of total heating surface.
30. Total B. T. U. delivered to the steam from the boiler.
31. Boiler capacity in square feet of direct radiation steam surface.

(This is obtained by dividing the total B. T. U. delivered to the steam by 250.)

32. Analysis of the flue gases.

Your Committee recognizes that there are some items named above which it will be difficult to obtain under all conditions, but which the Committee feels should be obtained where possible, as the fuller and more complete is the information in regard to each test, the fuller and more complete

will our information in regard to house-heating boilers become in the course of time.

In conclusion, your Committee desires to say that in the matter of preparing a code for testing house-heating boilers it has had aid from Professor J. D. Hoffman and Professor R. C. Carpenter, neither of whom is a member of the Committee to whom this matter was referred.

Respectfully submitted,
J. H. KINEALY, *Chairman.*
JOHN R. ALLEN.
W. L. BRONAUGH.
ALBERT B. FRANKLIN.
WM. M. MACKAY.
H. A. SMITH.

MINORITY REPORT OF JOINT COMMITTEE CONSISTING OF THE MEMBERS OF THE COMMITTEE ON STANDARDS AND THE COMMITTEE ON HOUSE-HEATING BOILERS.

The following recommendations are submitted with reference to the subject of boiler ratings:

1st. At the 1909 annual meeting the following resolution was passed and referred to Committee on Standards:

"*Resolved,* That it is the sense of this Society that in the absence of any standard for rating steam and hot-water heating boilers, one should be established based on coal consumed per square foot of grate surface and efficiency."

2d. It is recommended that the rate of combustion be determined as follows:

(*a*) Divide boilers into four classes.
Small boilers less than 6 sq. ft. grate area.
Medium boilers 6 to 10 sq. ft. grate area.
Large boilers over 10 sq. ft. grate area.
Heavy duty boilers over 20 sq. ft. grate area.

If the boiler has a magazine feed or a fire pot of an irregular shape, the class to which it belongs shall be determined by the mean effective area of fire pot on same basis as the grate area above specified.

(*b*) Fix the firing period for each class.
Small boilers 8 hour run on one firing.
Medium boilers 7 hour run on one firing.
Large boilers 6 hour run on one firing.
Heavy duty boilers 4 hour run on one firing.

(*c*) The maximum coal burned during one firing period to be 80 per cent. of the fire pot capacity when filled to a depth specified by the maker, not to exceed the centre of fire door or a total depth of 20 inches from top of grate bars, unless the boiler is magazine feed, when the coal burned must not be more than 80 per cent. of the magazine capacity.

3d. It is recommended that the efficiency to be claimed be determined by actual tests, when the boiler is operated in accordance with the foregoing division as to classes, firing periods and rate of combustion, using stove size anthracite coal as the standard fuel.

4th. It is recommended that the capacity or rating be calculated as follows:

Let C represent the pounds of fuel available for one firing period.

Let T represent firing period in hours.

Let E equal the total B. T. U. considered available per pound of fuel at boiler outlet, not exceeding results shown by tests.

Then $\frac{C \times E}{T}$ represents the boiler capacity per hour in B. T. U.

If rating is desired in equivalent square feet direct radiation, divide capacity in B. T. U. by 250 for steam and 150 for hot water.

5th. It is recommended that a standard test code be used in making tests to determine the efficiency for rating, and a special heating boiler test code committee be appointed by the new president to prepare such code embracing the conditions heretofore specified, and to report at the next annual meeting.

6th. This method for rating heating boilers will give the widest possible latitude to individual manufacturers and com-

mercial requirements, as it provides for the classification of size and rate of combustion, from which an accurate heating surface ratio can be determined by the designer according to the efficiency which seems possible or advisable.

Respectfully submitted,

P. H. SEWARD.

January 10, 1910.

DISCUSSION.

E. D. Densmore: Among the papers which are to be presented at the annual meeting I find the report of a joint committee, consisting of the members of the Committee on Standards and the Committee on House Heating Boilers. I am a member of the Committee on Standards and am interested in this report. I have previously written to Mr. J. H. Kinealy, Chairman of the Committee, that I do not approve this report, and I am writing to you so that this fact may be presented at the meeting. There is no mention made of the fact that certain members of the Committee, together with Mr. Snow, President of the Society, who is a member ex-officio, do not approve the report.

I take particular objection to the following points:

1. A table of ratings which represent the average of the ratings submitted by each member of the Committee. The ratings as submitted by the members cover quite a wide range, and there is no scientific reason for assuming that the average of these is preferable to any one of them.

2. The suggestion that a committee on boiler ratings be appointed yearly by the Society to consider claims which manufacturers make for special rating for any boiler. Such an arrangement as this would detract from the professional standing of the Society.

3. The form of test submitted is incomplete, in that it does not cover questions relating to water heating boilers as well as steam boilers. Further, the form of test is not worked out carefully enough, and it is my opinion that this form of test is a very important matter and should be referred to a special com-

mittee on boiler testing. I think there should be a complete form of test as well as an abridged form.

I trust that the fact may be brought before the Society when this paper is presented, that I do not consider the report as it stands proper.

President Snow: The title, Report of Joint Committee, consisting of the members of the Committee on Standards and the Committee on House Heating Boilers, together with President Snow acting ex-officio, makes it incumbent on me to state that the report as presented is a majority report, but that I have been unable as an ex-officio member to agree in many of the conclusions reached.

Taking up the report in detail by the numbered paragraphs:

(1) I believe the definition of grate area could be improved on.

(3) The table presented is, as I understand it, the average of eight estimates, votes or opinions as to ratings based on what were considered fair rates of combustion and efficiencies for boilers having different grate areas when operated under practical working conditions in service.

Test conditions would naturally be expected to show higher ratings. How much higher is a question to be determined by the proposed Boiler Rating Committee?

To my mind there are several objections to having such a committee. In the first place, I do not believe it to be a function of this Society to settle such matters for manufacturers and am unable to see how the Society could act without conflicting with Article X of the Constitution, which states in effect:

> Recommendation, endorsement or approval shall not be given to or made for........any mechanical or engineering production.

The opinion of the Society must not carry with it the promotion of the interests of any individual, firm or corporation.

Aside from the question of constitutionality, it seems to me that this committee would be literally swamped with work in case the recommendation of the committee is adopted and the

manufacturers show a desire to take advantage of its provisions.

Would there not be likely to be great delay in establishing ratings in this manner?

It seems to me that such a committee as the one proposed could hardly transact its business by correspondence.

The holding of meetings with sufficient frequency to pass on questions that may arise in connection with boiler ratings, it seems to me, would be difficult to accomplish.

As to the test code offered, I believe it is well to bear in mind the vote under which this work has been done, viz., that "in the absence of any standard for rating steam and hot-water heating boilers one should be established based on coal consumed per sq. ft. of grate surface and efficiency."

While the complete code and perhaps a still more complete one may be desirable, I believe that a shorter one will fully comply with the vote. Items 8, 9, 10, 19, 23, 29 and 32, while interesting and desirable, could, I believe, be omitted and still comply with the vote.

It seems to me (1) that the steam pressure should be stated, (2) that it should be mentioned whether or not boiler is covered, (3) that the amount of priming or moisture in the steam should be limited to a certain per cent., (4) that the efficiency should be worked out and stated.

This committee has secured interesting and valuable data, but I do not believe has fully or finally solved the problem.

With the data secured and the discussions at this and the Indianapolis meeting before it, I believe a new committee to be appointed by the president-elect, to which I hope this matter will be referred, will be in a position to further the work and bring the matter to a satisfactory conclusion.

Mr. May: It seems that both the majority and minority committees have made certain suggestions which should be considered seriously by this association. As a member of the association I do not think it would be advisable, with the rather diverse opinions held by members of the committee, for this association to adopt and use either formula which has been proposed as a standard.

In the first place, taking the majority report, there seems to

be nothing taken into account with reference to the different designs of boilers, whether such a boiler be round or whether it be of the sectional type, and it seems to me rather stretching the point somewhat to say that a boiler with a certain definite grate area shall be definitely rated at a certain fixed amount of radiation. In the first place, we all know, or those who have had any opportunity to consider boilers and their design, must know, that the arrangement of the heating surface, the size of the flues in the boiler, the conditions as regards draft, the depth of fuel, all have a bearing on the efficiency of the boiler; and to say that a boiler with one square foot of grate area, burning coal at the rate of 2.67 pounds of coal per hour, must develop an efficiency figured out on the basis of 7.98 pounds of water per pound of coal, does not seem logical. The committee in their test recommend that there shall be fired 50 pounds of coal per square foot of grate surface after the boiler has run under normal conditions for one hour. Taking the average condition of fifty pounds of anthracite coal to a cubic foot, that means a depth of fuel of one foot or twelve inches. The committee, however, have seen fit in their recommendations to say that the total coal burned per hour shall be 2.67 pounds per square foot of grate, and that a small boiler—and assuming that they mean a smaller boiler—shall run on an eight-hour basis, that means —and I am also going to take the liberty of assuming that they must have a reserve power for rekindling a fair amount of fuel, I am going to allow them twenty per cent.—it means that it shall have a total fuel capacity of 26.7 pounds. And yet in their test they say we shall burn 50 pounds of coal. Taking their statement of 26.7 pounds, it means that we must have a depth of fuel for an eight-hour run of 6.7 inches.

Now, any one who has had any experience with a house-heating boiler and run it without attention for eight hours, can readily see that with six inches depth of fuel in a short time we are going to have no fire at all, and no evaporation. And further, any one who has had any experience with tests knows that at the rate of 2.6 pounds of coal per hour that it is very rare that you can get an evaporation of seven pounds of water per pound of fuel, even though on the dry fuel basis the heating value is 13,000 heat units. With a boiler of one square foot of

grate surface, it means evaporating on the test basis 8.99 or, say, 9 pounds of water per pound of coal on the four-hour basis with a depth of fuel of 8 inches; and yet they allow the fireman to go away for four hours and hope to keep up an evaporation of 9 pounds of water per pound of coal with an 8-inch depth of fuel. In the past ten years I have had the opportunity of considering something in the neighborhood of over 2,000 tests; and I say that taking all types of boiler, not confining the effort to one particular type, that no boiler has evaporated on a 2-pound rate of combustion any such amount of water as is necessary on the committee basis.

The committee has not seen fit, however, to define what shall be 6, 8 or 4-hour period boilers. They call them small, medium or large. We presume that Mr. Seward, in his paper, has defined those propositions. It is unfortunate, Mr. Chairman, that this committee did not report to the body here the efforts of the National Association of Boiler and Radiator Manufacturers, who have worked in all fairness to get together, if it was possible, and recommend a uniform *method* of rating boilers, not a uniform rating, because we know that is impossible, but a uniform method of rating boilers. That association, the Association of Boiler and Radiator Manufacturers, held innumerable meetings, appointed committee and sub-committee. These committees gave the most careful consideration to the subject, and they recommended to the committee appointed by this body a formula or a method of rating boilers which I believe if it were put before you would be the only basis which this body could hope to follow out until opportunity has been given for a further consideration and for a method or a series of tests to be carried out by this body, if it so please, and from which they can adopt their own formula. That formula laid upon the national association or upon boiler manufacturers the obligation to guarantee their ratings; and it seems to me that if the manufacturer will guarantee to you his rating, that under certain conditions that boiler will evaporate so many pounds of water per pound of coal, under average conditions, as the coal is received from the mine—not under laboratory diagnosis of the coal-heating value, but under the average conditions of the coal as the house-owner finds it in his cellar—if they will

guarantee that under those conditions the boiler will evaporate so many pounds of water per pound of coal when run at a certain rate and under normal conditions of draft, that that is all that this body or any other body of engineers can ask for. And I say to you if a boiler when run at the rate of combustion of 10 pounds of coal per square foot of grate will show an efficiency just as great per pound of coal as when run at 4.8 pounds of coal, is it up to this Society to say that the manufacturer shall not print that, unless the boiler is run at the rate of 10 pounds of coal per square foot of grate, the boiler will develop an efficiency which will give a rating of 1,300 rather than 700, as the committee has laid out? Is it fair for this body to say to the manufacturers: "You are all wrong; your boiler will not develop that capacity," when they know it will develop that capacity?

I do not believe, gentlemen, that we are in a position as heating engineers to arbitrarily set ourselves on a pinnacle, when the manufacturers, several of them, have been in a position to test and have been testing boilers for ten or twelve years and longer, and they know that a boiler run at the rate of 2 pounds per square foot of grate, or 2.6 pounds, will not develop an efficiency of 7 pounds of water, but will develop along about 5 pounds; but when run at a rate of from 6 to 10 pounds that it will evaporate from 8 to 8½ pounds of water. When they state so and so and guarantee it, it is up to us to take it on their basis and make them prove it; and if they cannot stand back of their ratings it is up to us to make them. If the manufacturer will give to us the rate of combustion and evaporative efficiency per pound of coal, anthracite or bituminous, as he may see it, and if he will guarantee that, what more can we ask?

Mr. H. A. Smith: I should properly add to the report, as a part of it, this, which I received from Professor Kinealy: "Report of the Committee of the National Boiler and Radiator Manufacturers' Association." (Reads): The idea here seems to be that we may say to the manufacturer, "You shall not rate your boiler at 1,000 feet; you must rate it at 2 x 5 x 4 x *n*, the value of *n* to be fixed by you." If the manufacturer is out of the kindergarten he will probably substitute 25 for *n*, giving him a 1,000-foot boiler. In other words, it would nullify the whole

proposition if we leave the efficiency to be set by the manufacturer and allow that factor to govern the rating.

Professor Carpenter: I wish to call the attention of the Society to a short analysis of the report as it stands before us. It seems to me that our discussion this evening should not be on the merits of the particular things which are referred to in the report; neither should it be along the best methods of making tests. If we go into those things we shall simply waste our whole time, and we will not arrive at any conclusion whatever. For that reason I hope the members of the Society will stick closely to the text and talk about what these reports should contain and not how we are going to get the information. I think that part can be taken care of after we agree on what is wanted.

I wish to make a comparison of the two reports. I find that they agree in principle. They differ very materially as to how far we should go into details in defining the standards. The majority report suggests that we divide heating boilers into a large number of classes by means of an arbitrary table or rule which they have given, but the derivation of which they have not explained. I do not believe that any of us understand, and I think very few of us appreciate why boilers should be classified in that way. The table certainly does make the proposed system a very complicated one. Both majority and minority reports propose a standard based on the area of the grate. Both reports agree on a basis for the measurement of the capacity of the boiler. Both of them propose to measure the capacity on the B. T. U. basis, and to consider one square foot of radiator as requiring 250 B. T. U. per hour. Both reports agree in recommending that a committee be appointed on boiler tests.

The principal point of difference is in the proposed classification. Mr. Seward, in his report, has divided boilers into four classes. I assume, that as a matter of simplicity and convenience they are put into four groups instead of a greater number of groups. He assumes the firing period for each of these groups as varying from eight hours to four hours. In the majority report the time interval of firing is stated as not being less than eight hours, otherwise the time of firing is not definitely fixed.

We made numerous investigations this last year in the line of testing heating boilers. We found that the time interval of firing has a good deal to do with efficiency. We obtained higher efficiency from a given boiler with short intervals between firing than when the firing intervals were long. Consequently the length of the firing interval is a matter of considerable importance. We found, however, no difficulty whatever in operating the boilers with an eight-hour interval between firing. In the beginning we lost our fire three or four times, but after some experience there was no trouble whatever in working with a time interval between firing of five to eight hours.

I do not see why it is unfair to the manufacturer or any one to specify that a boiler of a certain size should for standard test conditions be fired in a certain definite way which corresponds approximately to general practice. I do not see how the recommendation made by the minority is not perfectly fair. It will doubtless change present boiler ratings. However, everybody will be put on the same basis, so that the final results will be fair and the purchaser will know what to expect.

I like the suggestion in the minority report that the question of efficiency be left to the boiler manufacturer as an inducement for good results. The purchaser then will buy the boiler on the size of grate as a basis, his inducement will be on the basis of what the boiler accomplishes; in other words, on its actual efficiency. It seems to me that is a good, sound, practical recommendation. It is important in all cases to have a standard which is practical and easily understood. The standard that the majority of the committee has proposed is good in many ways, but is complicated and difficult to apply. The minority report, I think, has simplified the matter and put it in practical shape; for these reasons I like its recommendation better than that of the majority.

The reports differ in other minor respects. The majority report suggests a number of items which should be recorded in cases of tests. Those items are taken from the American Society of Mechanical Engineers' boiler code and are doubtless necessary. Mr. Seward suggests in view of our present information that at the present time it would not be desirable to

state how the tests should be conducted. This I believe is the correct position at present.

I believe that it would be desirable if the Society could include in its proceedings the letters and discussion which the committee received from various members. I know that I worked up an elaborate letter based on my experience in testing heating boilers. I presume Professor Hoffman and others did the same thing. I think the matter contained in those letters would be of interest to the Society.

Mr. Macon: In order to bring the matter to a head, I move the adoption of the minority report. I make that motion partly because the criticisms of an adverse nature seem all to have been directed to the majority report. Certainly the provisions of the minority report are broad and the consensus of opinion seems to be that the majority report is not satisfactory. The minority report allows for establishing, as early as possible, a standard for rating and allows the committee to work during the succeeding year on developing a satisfactory testing code; having the data for rating boilers, it is desirable to have some uniform method of making tests.

The motion was seconded.

Mr. Weinshank: I want to make an amendment that the minority and the majority reports be received and placed on file. I do not believe the Society is ready to adopt either one of the reports. If the Society adopts the minority or the majority report that means the Society approves that method of rating or that method of testing. We are not in a position yet to approve either. I therefore make a motion that both reports be accepted and placed on file.

The amendment was seconded.

Mr. Smith: I move as an amendment to the amendment that the chair appoint a committee which shall condense and unify the two reports in a satisfactory manner.

Mr. Weinshank: With the consent of the gentleman who seconded my motion I will accept this amendment.

Mr. May: In the reading of the recommendations on the part of the boiler and radiator manufacturers as given to the general committee there was a classification of boilers into two classes, which is a simplification of the minority report, being

a rating of boilers which have the minimum of attention, that is, in the ordinary house installation.

President Snow: As I understand it, the amendment is that the majority and minority reports on boiler rating be received and referred to a committee on boiler rating to be appointed by the president-elect to be reported to the Society.

Mr. Barron: I think the opinion of the members is that this matter should be disposed of. But I think the way it has been gone at puts it in rather awkward shape for our proceedings. This getting gentlemen to do a lot of work for our Society and then turning it over to another committee to succeed them I do not think is wise. I think this should be fully discussed now and the opinion of gentlemen who are interested in the designing and construction of boilers given, to be made a matter of record. I am opposed to the acceptance of the report.

Mr. Seward: As I understand it, this new committee would be privileged to go back to the start of this whole question and work it up from a new basis if they saw fit, taking into consideration what had been done up to this point. I would like to see some progress made on this matter, and I think a great many others would. It is a very disturbing question. It is upsetting the heating industry more or less, and has everybody confused. It has been considered for quite a long time, and it seems as though we have made sufficient progress to enable us to take some action.

Now, I would like to explain some of the features in connection with this so-called minority report that possibly have not as yet been brought out and which may throw some light on the question.

In the first place this Committee on Standards is working to the resolution that was passed at the 1909 annual meeting. The resolution is given in the minority report in full, and I think it is the real cause of the disagreement in the committee, owing to the difference of opinion as to how it should be interpreted. I have been pleased to interpret it right from the start as calling for a *standard for rating* steam and hot-water heating boilers, whereas some of the members of the committee interpret it to means that we should adopt a *standard rating* for steam and hot-water heating boilers and not a standard for rating.

The majority report mentions a standard rating by which all boilers can be compared and measured. I have contended that such was not the meaning of the resolution. If you will look up the definition of the word "standard" in the dictionary you will find as one meaning the one I have put upon it, "a combination of conditions accepted as correct." I have always read the resolution in this way: "That it is the sense of this Society that in the absence of any combination of conditions accepted as correct for rating steam and hot-water heating boilers, one should be established based on coal consumed per square foot of grate surface and efficiency." That is the point from which I have worked and it is just opposite to the work of the majority of the committee.

Now this minority report of mine is nothing more nor less than a series of recommendations or conditions which go to make up a method of rating, which, if accepted by this Society, could become a standard method of rating. There is nothing compulsory about it. There is no legislation embodied or suggested. I do not believe this Society has any right to legislate. I think that all it can do is to recommend that certain conditions be accepted as standard, and then it is the privilege of anybody in the business to accept those recommendations or not as they see fit. It is a good deal like the recommendations of the Standardization Committee of the Electrical Engineers' Society. They standardize and recommend certain names and factors, which are then accepted by the trade in general, not because of legislation, but to facilitate business. The Society does not say that you should accept any of those things, but say they recommend the acceptance of the terms or measures specified for arriving at certain values. Therefore I purposely in this report made everything in the shape of a recommendation, so that if the Society did see fit to adopt it we would not commit ourselves to anything except strictly a recommendation that anybody could follow if desired.

You will further see that the resolution to which we are working, after it mentions the absence of any standard for rating steam and hot-water boilers, says that one should be established based on the coal consumed per square foot of grate surface and the efficiency. There seems to be a difficulty right at the start in arriving at a basis of calculating the coal con-

sumed per square foot of grate surface, as it is generally recognized that the rate of combustion should vary with different size boilers, and it therefore seemed wise to me to divide heating boilers into four classes, as shown in the minority report, and this division was made, as far as I could determine, with reference to the class of buildings in which the boilers of such sizes would be ordinarily installed; small boilers for residences where they would get the minimum of attention; medium boilers for buildings where a janitor would attend to them; large boilers for buildings where they would have more or less attention of a fireman; and heavy duty boilers for a building where they have a regular skilled attendant or engineer. There is also a division into classes for the purpose of arriving at the second feature, which is the firing period; the small boilers running eight hours on one firing, and then down in proportion until you come to four hours for the large one. Practically everybody that buys or makes boilers figures that the small boiler for residences should run eight hours on one charge of fuel, and as the boiler gets larger the firing period should be reduced. I do not believe there has ever been anything specifically stated as to how that reduction should be made, and I have mentioned it in the report in order to get it into a concrete form.

Then we come to feature "C," which, in connection with "A" and "B," determines the rate of combustion, as is necessary according to the resolution under which we are working. Now you will notice that "C" provides that, practically speaking, the manufacturer of a boiler can assume any rate of combustion that best suits his purposes up to a certain limit. The idea of which is this: boilers as made and sold to-day cover a wide variety of conditions. Some buyers of boilers and some users of boilers like to have one that is high in efficiency; others prefer one that is high in capacity, regardless of efficiency. Now that is a condition that we face, and there is nothing that we can do here, so far as I know, that will ever change it. We cannot compel people to buy any particular kind of boiler. If they choose to buy a boiler that is high in capacity and possibly low in efficiency, that is their privilege, and there will certainly be manufacturers to make boilers to suit any demand that may

exist. Therefore, if we have any standard of conditions to suggest they must be for all classes of boilers or else they will not be complete.

You notice here that the report provides for the rate of combustion to be determined by the capacity of the fire pot to hold coal. I think that is the real basis of calculation. The eighty per cent. feature is stated to provide a remaining bed of fuel equal to twenty per cent. of the original charge for igniting the fresh supply, and that also seems to be accepted as a standard to-day, therefore there is no good reason to change it.

The idea of making the maximum depth twenty inches is to enable all styles of boilers to come in under that classification. The greatest depth of fire pot that I know of in any boiler is twenty-two inches. That boiler is a commercial success. It is made in quantities, and many people buy and want it, because it is low in price and high in capacity. There will always be a demand for such a boiler, and it is foolish to try to legislate it out of existence. This kind of boiler may not be economical, but if it is high in capacity and low in cost and therefore appeals to people anything that we adopt must be applicable to it, and that is one reason why I have changed my ideas on rate of combustion during the current year. I started out with the idea that we ought to compel boilers to be made with a high efficiency; but I now think it would be a mistake. I think there are a great many people who prefer to sacrifice efficiency to other things, such as the first cost, ability to work on poor draft and features of that kind which determine design and construction and which will always have to be met.

Then the third recommendation here is that the efficiency be determined by actual tests when the boiler is operated in accordance with the rate of combustion that will be determined by the previous suggestions. Of course, that is practically of no consideration at all, as there is no way to obtain efficiency except by actual test, and all manufacturers do it except that they do not state their conditions under which the tests were made. Every maker has a different set of conditions under which he works known only to himself, and which he necessarily considers as correct.

Now, this recommendation as to the determination of the rate

of combustion fixes a condition which, if it were accepted as a standard, would, I believe, be adopted by all manufacturers because it does not interfere with their present construction or any construction that they may design in the future, so far as I can read the future. The formula is nothing more nor less than a simple suggestion for multiplying and dividing certain factors together to get the result desired. You notice the "E" should be the total B. T. U. considered available by the manufacturer. He can himself determine what is the actual efficiency of his boiler or the work it will do per pound of coal; but he need only give out commercially any part of that that he sees fit for his purpose. He does not need to take it all; he can take any part of it, so long as it is not over and above what his tests would substantiate.

The recommendation as to the standard testing code committee is, I believe, contained in the majority report, but I do not believe they covered it completely, and that is the reason I suggest that that particular feature be referred to a new committee, as I think that we have made enough progress now so that what we have done can be accepted, and the test code committee could work from that point on. In this way we would settle the rating question to a certain extent at the present time, and we would relieve the commercial conditions, which are very embarrassing, very annoying and make trouble for everybody, not only the maker, but the engineer and the architect.

My conclusion is that this method of rating boilers would give the widest latitude to the manufacturers, as I have explained, although there has been some criticism, especially as to the rate of combustion for different classes of boilers. Professor Kinealy has contended from the start that the increase in the rate of combustion should be by curve or formula progressing in straight lines from the small boiler to the larger one. I have attempted to explain to Professor Kinealy, but without success, and will now explain to you why I regard such a suggestion as totally impracticable for any boiler manufacturer to live up to.

If you will recall, house-heating boilers are nearly always made of cast iron, and made from patterns in sections, which are machined and assembled together to produce different size

boilers. I think it will be generally accepted as a fact by any engineer that after you have determined the efficiency of your heating surface there should be a constant ratio between the amount of such heating surface and the coal burned. If your heating surface has a value of 2½ pounds of water to a pound of coal, and you increase your rate of combustion you must necessarily increase your heating surface. In other words, there must be, for good engineering, a constant ratio between the heating surface and the coal burned. Now I would like to ask how we can build a boiler of cast iron, as they are built to-day, and maintain a constant ratio between the coal burned and the heating surface, by progressing the rate of combustion as Professor Kinealy has mentioned in his table? I regard it as absolutely impossible, and I think every boiler manufacturer who knows anything about it would back me up.

Now, by dividing boilers into four classes, which is really for the purpose of determining the rate of combustion, you overcome that objection. The small boiler can be built, with its heating surface value known, at a constant ratio from the smallest size of that class to the largest. When you jump into the next class you can adopt any other form of construction or any other form of assembling, and you can maintain the same constant ratio again, and so on up to the highest division. I regard this as a very important feature, and one that I wanted to bring up before you voted on the question.

Now, I do not think the boiler buyers of this country are mechanical engineers to any degree. I think all they want to know is the efficiency of the boiler, and if it is rated under certain standard conditions. If the conditions do not suit their purpose they can change the factors to get any rating they desire.

I think we have made real progress in this matter, and I would like to see the progress that has been made accepted, and that the proposed test code committee work from this point on. I think we will commit the Society to nothing definite whatsoever. The final solution of this matter is in the hands of this test code committee, because that test code, if properly drawn, will embrace the conditions that are alluded to herein or be changed in some manner, perhaps, if they see fit.

Professor Carpenter: As I understand the question relating

to standards, it does not involve the Society. So far as I know, societies when accepting standards are not bound by them as a society. It is a committee report which is seldom formally adopted. President Snow has pointed out the following statement in the constitution of the American Society of Mechanical Engineers: "Reports of such committees may be accepted by the Society and printed in the Transactions, but shall not be approved or adopted as the action of the Society." That statement explains the policy of the A. S. M. E. as to reports on standards. I think we should follow the same policy. I believe we should keep this question before a committee. Since Mr. Seward has spoken I am inclined to think that there are some recommendations that we are ready to accept, and some that we are not ready to accept. I do not think that we should adopt anything or approve anything.

Mr. Weinshank: Let me ask the professor a question, Isn't it a fact that all the standards which are accepted by the Mechanical Engineers or the Electrical Engineers have been approved and adopted and are being used by the trade?

Professor Carpenter: Not officially. Doubtless they have been accepted by the trade. In absence of anything to the contrary they certainly have weight.

The reports to other societies, as far as I know, with one or two exceptions, have never had any endorsement from anybody. They are simply accepted, and they are open to amendment and change at any time or when anything better can be presented.

Mr. James Mackay: We have here a report of the regular committee signed by a member. We also have a minority report signed by one member of that committee. We have a letter from another member of the committee. I don't know whether he has had an opportunity to digest and sign this minority report or not. We also have Mr. Snow's explanation of his position in the matter; so we really have four reports. Now it seems to me the amendment should carry, because the matter is rather in an unfortunate state. Neither of these reports is acceptable.

Mr. Gates: Recently a number of manufacturers have made exhaustive tests of their boilers, and it would seem to me that the information would be of value to the Society. The ma-

jority and the minority reports seem to be widely different, and I think that the appointment of a new committee would have the benefit of what has already been done and the disposition of the manufacturers to meet the engineers will result in some standard method which will be acceptable to both the engineers and the manufacturers. The appointment of President Snow's committee, which he suggests, by the president-elect, would go a long way toward solving the problem.

The question was called for.

President Snow: I will rule that the amendment is in order which reads: "Moved that the majority and minority committee report on boiler rating be received and referred to a committee to recommend to the society a method for rating heating boilers, this committee to be appointed by the president-elect."

The amendment was put and carried.

Now, as I understand it, we have not adopted the thing yet, and we have got to vote on the original motion as amended or else we do not have a vote on anything.

The question on the original motion was called for.

Mr. Berry: I would like to say a few words on it before you go ahead. I do not represent any manufacturers and I think I come more in the class of the people who use these different appliances. I think the members of the Society feel that the minority report, or the report of both committees, for that matter, is a step in advance and a step which this Society has been trying to make for quite a number of years. The whole matter has been very indefinite, and of course it is bound to be so long as the manufacturers are going to look at it absolutely from their standpoint, the standpoint of profits, possibly, from the sale of boilers.

Now, as engineers, we are in a position to recommend to our clients different appliances, and we haven't anything to use as a standard. I feel as if the minority report, if it should be accepted and printed and the matter continued in the form of a committee, as has been suggested, would be a great help to the practicing engineer, the man that is in the position where he has to say a boiler will do certain work. If we had some form by which we could state that a boiler tested in this form

would have a certain rating, then the manufacturer, if he does not wish to, need not conform to that, but we have got something that we can rely upon in a practical way. And I hope we may accept and print the minority report in the minutes and then go ahead from that point.

Mr. Seward: I would like to explain why this minority report has not been previously submitted to the members. It is called a minority report purely by courtesy. Three members of this committee met together since the majority report was received and agreed substantially that certain things in it were wrong, and drew up a rough draft of some suggestions that could be made correct. I myself informed the Secretary that I had a minority report to submit and I asked him that it be printed and distributed to the members with the majority report, so that they would have time to digest it. I would very much like to see the points in connection with it that are thought wrong brought out to enable the next committee that takes hold of it to have something to go by, and not be compelled to act by their individual efforts as we have in the past.

Mr. Gates: It would seem to me, listening to the two reports, the majority and minority, that you have brought out a good many facts that are valuable to the Society; but you have not brought out in either report enough facts. You have made a long step forward. Now, manufacturers for the past sixty days have been making a great many tests of their boilers to arrive at a method of testing boilers. They are ready now, as never before, to meet the wishes of the Society, and it seems to me the proper thing would be to receive both of these reports, and file them, and then take this matter up with the manufacturers. These data are valuable to them and the new committee can carry on this work where the majority and minority reports have left it.

Mr. Badger: There seems to be a great diversity of opinion as to how boilers should be rated or what should be the uniform basis for rating them, therefore I think the work should be carried on in this line and a further investigation of the subject should be made in order to do justice to both the engineers and manufacturers.

As I understand it, the amendment which was carried includes

receiving both the majority and minority reports of the committee and that the incoming president is to appoint a committee to continue this work. It deals with a difficult commercial problem, and I think that before this Society takes final action recommending a basis or standard, the subject should be investigated further and all interests more carefully considered.

I realize that this subject is a difficult one to handle, and that it is discouraging and hard work for a committee to arrive at a basis satisfactory to all, nevertheless with a further investigation and consideration, we may obtain this. It is at least worth the effort and labor. The work already done by this committee should be thoroughly appreciated.

CCXIV.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON CENTRAL HEATING PLANTS.

Your committee on Central Heating Plants desires to make the following preliminary report.

The literature on this subject is in a very scattered state, consisting mainly of isolated articles in magazines and reports of individual plants in the Proceedings of the Society.

In order to take up the subject in a systematic way the following natural division of central heating plants has beeen assumed:

I. Plants for heating public or semi-public institutions, such as asylums, hospitals, public schools, universities and similar institutions.

II. Plants installed for furnishing power and light to manufacturing plants involving a group of buildings.

III. Central plants erected for the purpose of selling heat to the surrounding community. These plants usually furnish electric current.

In all these plants the mediums used for heating have been either steam or hot water. In some installations both mediums have been combined, steam being used to heat the water circulated in the hot-water system.

Your committee in considering this subject has endeavored to investigate the literature now in print on this subject. The literature that has come to the notice of your committee has been classified under the headings as outlined above.

TYPE I.

Title of Article.	Nature of Article.	Source of Article.
Heating and Power Plant at Princeton Theological Seminary.	Heating by steam, includes also electric current generation.	*Heating and Ventilating Magazine*, June, 1908.
Mechanical Equipment of the Harvard Medical School Buildings, Boston, Mass.	Heating by hot water, includes also electric current generation and refrigeration.	*Heating and Ventilating Magazine*, January, 1908.

Title of Article.	Nature of Article.	Source of Article.
Plant for New York Juvenile Asylum, Doddsberry, N. Y.	Describes hot water heating plant and power plant.	*Heating and Ventilating Magazine*, April, 1907.
Heating of a Group of Public Buildings in Copenhagen. Author, A. C. Karsten.	Heating by hot water.	*Gesundheits Ingenieur*, May 25, 1907.
Heating and Ventilation of a Group of Public Schools at Galesburg, Ill. Author, S. R. Lewis.	Heating by steam, includes also electric current generation and furnishing of compressed air.	Transactions, A. S. H. & V. E., Vol. XIII, p. 187.
Central Heating and Power Plant for Cathedral and Schools, Garden City, Long Island.		*Heating and Ventilating Magazine*, March, 1906.
	TYPE II.	
Heating Group of Car Shops in Baltimore for the United Railway and Electric Co.	Heating by steam.	*Engineering Record*, November 9, 1901.
	TYPE III.	
The Schott System of Central Station Heating. Author, J. C. Hornung.	Includes heating by hot water and steam.	*Heating and Ventilating Magazine*, November, 1908.
Some Facts and a Few Theories Concerning the Operation of a Central Station Hot Water Heating and Electrical Generating Plant. Author, Prof. J. D. Hoffman.		*Heating and Ventilating Magazine*, October, 1908.
A Central Heating and Power Plant for the City of Springfield, Ohio. Author, W. N. Zurflush.		*Engineer*, June 15, 1906.
Central Station Heating. Author, William H. Bryan.	Discussion of fundamental features of Public Steam and Hot Water Heating by electric lighting companies.	Transactions, A. S. H. & V. E. Vol. VII, page 97.
Steam Heating for Central Stations.	Discussion of the addition of a central steam heating plant to existing power stations.	*Technograph*, 1904–1905.
District Heating.	Connecting of central heating plants with electric lighting stations.	Paper before National Electric Light Ass'n. *Engineering Record*, July 15, 1905.
Dresden Central Station.	Description of results obtained.	*London Engineering*, October 6, 1905.
A Study of Central Power and Heating Plant for Federal Building, Washington, D.C. Authors, Bernard R. Green and Prof. S. Homer Woodbridge.		*Engineering Record*, February 11, 1905.
Notes on the Design of Central Station Hot Water Heating Systems. Author, J. D. Hoffman.		Transactions, A. S. H. & V. E., Vol. XI, page 199.
Central Station Heating. Author, W. H. Schott.	Discussion relative use of hot water and steam for central heating.	Paper before Northwestern Electric Light Ass'n. *Domestic Engineering*, Feb. 25, 1904.
Heating from Central Station. Author, H. W. Pearce.	Showing that with proper appliances and experience heating from central station is a success.	*Journal Western Society of Engineers*, February, 1904.
Hot Water Central Heating, Red Oak, Ia.	Description of plant utilizing exhaust steam from electric lighting plant for heating.	*American Gas Lighting Journal*, May 12, 1902.

Title of Article.	Nature of Article.	Source of Article.
Central Heating Plants in the United States.	Growth of Commercial Central Heating Systems.	*Engineering News*, March 20, 1902.
Heating from Central Stations. Author, A. D. Adams.	Description of steam and hot water for heating purposes, giving figures on relative cost.	*Municipal Engineer*, February, 1901.
Heating from Central Stations. Author, A. D. Adams.	Advantages of distributing steam heat from electric stations.	*Municipal Engineer*, March, 1901.
Hot Water Heating from Central Stations. Author, A. D. Adams.	Discussion of advantages.	*Electrical World and Engineer*, March 23, 1901.

In addition to articles dealing with general design and description of central heating plants, a few articles referring to some particular detail are given below:

Underground Insulation of Steam and Hot Water Pipes. Author, Harry Gillett. Extract from paper read before Ohio Society of Mechanical, Electrical and Steam Engineers. Heating and Ventilating Magazine, November, 1908.

Test of Underground Conduit Containing Hot Water Piping. Authors, E. Faris, L. J. J. Owens and C. J. Peck. Extract Thesis, "An Efficiency Test of the Merchants' Heating and Lighting Plant of Lafayette, Ind." Heating and Ventilating Magazine, October, 1908.

Meter Rate and Flat Rate in District Steam Heating. From the report of the Committee on District Heating, W. H. Blood, Jr., Chairman, National Electric Light Association. Heating and Ventilating Magazine, May, 1908.

Design of Pipes for Hot Water Heating from Central Station. Electrical Review, May 18, 1901.

One object in presenting this bibliography to the Society is to show how little literature there is on the subject. This is particularly so in the Transactions of the Society.

All of these articles, in general, are lacking in engineering data. The committee asks the members of the Society to call to the committee's attention any other articles that should be included in this list. It is also anxious that members should send to the committee or present to the Society articles which might increase the data now in existence referring to central heating systems.

Respectfully submitted,

J. R. Allen, *Chairman.*
Ralph Collamore.

CCXV.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON HEATING BOILERS.

Boilers for steam and water heating have received most generous consideration by our Society, and it is probable that the proceedings we have published contain more information about design and proportion of such boilers than can be obtained from any other source.

Several papers which show the result of careful thought and study of some particular feature of heating boilers have been presented by our members, but it is in the discussions that we find the most valuable and comprehensive treatment of the subject.

The consideration which is given to the boiler as a fundamental part of heating and ventilating installations is indicated by the frequency with which we find allusion to some of its features or functions in discussions on papers or topics dealing primarily with some other branch of the profession.

In the earlier meetings the heating boiler is alluded to and approached with more or less hesitancy and reserve; but in the later years more familiarity is shown, and every meeting has disclosed a growing tendency to give boilers the consideration they deserve as an active agent for the success or failure of heating and ventilating apparatus.

The feeling in regard to this power and function of the heating boiler which existed in years gone by is aptly shown in some remarks by Mr. W. J. Baldwin at the first meeting and printed in Vol. I. of the Proceedings, page 71.

Mr. Baldwin in telling some of his experiences in the business thirty years back (1865), said Mr. Blake and himself were at one time discussing methods of calculating requirements for a prospective installation, and he asked Mr. Blake, "How

do you get at the size of the boiler?" Mr. Blake replied, "You had better wait a little while." Mr. Baldwin was of the opinion that thirty years had not changed the situation much, and there was still considerable "rule of thumb" method being practiced.

At the first annual meeting the heating boilers were discussed in two papers dealing with internal circulation and methods for making joints in sectional constructions, which goes to show that our Society is invaluable to any engineer who is at all desirous of keeping in touch with such details of the profession as are receiving prominence in current discussion and investigation.

The question of a more desirable and accurate method of ascertaining and expressing the power of heating boilers was being agitated in 1896, and it is, therefore, not surprising that in Vol. II. of our Proceedings, which covers the second annual meeting, we find, on page 56, remarks by Mr. Jellett to the effect that makers' catalogues cannot be followed as to the economical generation of steam in house-heating boilers.

While the papers and discussions from that time to the present have been most generous in volume and have covered every phase of heating boiler development, it cannot be shown that any definite or fundamental rules have been laid down or established as to the best methods to be pursued in design, manufacture and operation.

The work of a Society such as ours is largely research, and it is problematical if its functions cover anything beyond or can be made to serve a more useful purpose than has been indicated. The lessons learned from our papers and discussions are apt to be carried away and used by our members in their every-day affairs, and as the difficulty which prompted their investigation is relieved, the subject is naturally more or less closed and disappears from our proceedings.

This is aptly illustrated by the question as to a relation between the steam and hot water rating of the same heating boiler. Prior to 1897 the practice was very variable and the resulting figures most confusing. There was no uniformity or any apparent effort to get at the real considerations. At the summer meeting in 1897, Mr. A. C. Mott read a paper

on the subject, and while there is no evidence of his suggestion being adopted or standardized, it is, nevertheless, a fact that since 1897 there has been and is a definite relation between the steam and water ratings of heating boilers, and on the basis which was outlined in the paper referred to.

It is very evident to me, from the most careful perusal of our proceedings, that no student of heating and ventilation can ever hope to be fully and properly advised on every phase of the subject without becoming one of our members.

The qualification for membership fortunately takes in all those who have the business at heart, whether as designers, manufacturers or erectors, and for that reason the Society is most valuable to each of us, no matter in what branch we may be engaged or interested.

I have compiled a list of the papers presented and topics discussed in Vols. I. to XIII. inclusive, also a subject index so that such information as may be desired in connection with investigation of some particular feature of heating boilers can be readily located and referred to.

Respectfully submitted,

PERCIVAL H. SEWARD,
Chairman.

PAPERS AND TOPICS.

TOPIC: "What is the relative value of firebox and flue surface in boilers?" Vol. III., p. 212.

TOPIC: "How many feet of direct water-heating surface can be supplied with heat from one square foot of heating surface in a combination hot-air and hot-water heater?" Vol. III., p. 229.

PAPER: "The relation that should exist between the steam and water ratings of house-heating boilers." A. C. Mott. Vol. III., p. 258.

PAPER: "The rating of steam and hot-water boilers for heating purposes." James Mackay. Vol. VI., p. 160.

PAPER: "Effect of circulation on the capacity of firebox heating surface." R. C. Carpenter. Vol. VII., p. 185.

PAPER: "Volume of water in hot-water heating apparatus." W. M. Mackay. Vol. VII., p. 236.

TOPIC: "What is the advantage (or disadvantage) of broad grates with shallow firing over deep fireboxes and intense concentrated fires on small grates in hot-air furnace heating?" Vol. VIII., p. 166.

TOPIC: "What is the proper proportion of grate surface in a boiler to radiating surface in a building in a low-pressure steam and in a hot-water heating system?" Vol. VIII., p. 173.

"REPORT of special committee on the relation of grate area in heating boilers to the direct radiating surface in building." Vol. IX., p. 22.

PAPER: "Heating boiler development." H. J. Barron. Vol. IX., p. 153.

PAPER: "The capacity of cast-iron sectional steam boilers." J. J. Blackmore. Vol. IX., p. 161.

TOPIC: "In proportioning boilers for heating purposes, should the boiler be proportioned to the building to be heated or to the radiation provided?" Vol. IX., p. 191.

TOPIC: "Should the heating engineer be expected to provide reserve power in the heating boiler after proper allowance is made for radiation and piping in accordance with manufacturers' ratings, to insure the owner an efficient and economical apparatus?" Vol. IX., p. 204.

TOPIC: "For plants where the steam pressure does not exceed 100 pounds, which is to be preferred, a water-tube or a fire-tube boiler?" Vol. IX., p. 215.

TOPIC: "What is the proper method of rating steam and hot-water boilers for heating purposes?" Vol. IX., p. 289.

TOPIC: "Are all types of sectional cast-iron boilers adapted for steam heating?" Vol. X., p. 175.

PAPER: "Test of a steam-heating boiler." R. C. Carpenter. Vol. XI., p. 120.

TOPIC: "The requirements of house-heating boilers using bituminous coal." Vol. XI., p. 140.

TOPIC: "Proportion of grate surface required for different fuels." Vol. XI., p. 146.

TOPIC: "Is the present ratio of flue area to grate area in cast-iron heating boilers conducive to economy?" Vol. XI., p. 269.

TOPIC: "The chemical and physical properties of cast-iron used in boilers and radiators." Vol. XIII., p. 292.

TOPIC: "The benefits derived from the use of fusible plugs in cast-iron steam boilers." Vol. XIII., p. 296.

TOPIC: "The advantages in efficiency and economy of one large or two smaller boilers for carrying the same large amount of radiation, assuming in either case ample capacity for the work." Vol. XIII., p. 297.

TOPIC: "The size of standard firebox boilers which should be provided to supply 1,500 pounds of steam per hour for direct radiation at 3 pounds pressure, burning hard coal, with a 60-foot chimney and good draft." Vol. XIII., p. 299.

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CCXVI.

REPORT OF COMMITTEE ON AIR WASHERS.

It is admitted that the purification of air is vital, and that the engineering connected therewith is most important and interesting. Ever since there have been any attempts made to ventilate buildings efforts have been made also to remove the impurities from the air admitted. With the congestion of population in cities and the burning of bituminous coal it has become even more important to cleanse the air. With the wide use of fans for ventilation and the accompanying high air inlet velocities, quantities of dust and soot are pulled in and unless arrested and disposed of they reach and pollute the ventilated apartments. Almost every conceivable type of apparatus for removing the dirt has been tried. It is highly desirable also to purify the air by removing objectionable gases and odors. Dry filters of wire and cloth are in use. To be permanently effective they must be cleaned continuously or they merely hold up the impurities so that they may contaminate more air, and very soon become so clogged that the free area is curtailed.

A cleaner of this type is now on the market, which consists of a series of wire screens, over the inlet side of which hollow slotted suction arms under a considerable vacuum are constantly rotated. The vacuum is induced by means of a small centrifugal exhauster, and the screens, thus kept free from clogging, are maintained at their highest efficiency. This type is very economical in operation, as it does not require any preliminary tempering coils, and the maintenance of the vacuum is a trifling expense. This cleaner does not affect the temperature or humidity of the air, and is therefore advantageous in many respects. It appears doubtful whether or not it will eliminate from the entering air all minute particles of dust, but has without question an efficiency high enough to justify its installation in many buildings.

Cheese cloth bags in the air inlets to gravity indirect plants

in even the residence sections of cities will often become black and so clogged that they become practically inoperative in twenty-four hours. However, if designed with ample free area, and changed every few hours, they are very effective in removing dirt and soot. The bag type seems to give the greatest free area in a given space of any cheese cloth cleaner. The bags should be made of inexpensive material and when removed should be burned.

There is a dry air cleaner on the market which is composed of a sheet or belt of heavy special cloth, which is supported on zigzag frames and is so designed as to present a very large surface to the passage of air. The velocity through this substance must be very low and the space required renders it a difficult task to find room for its installation in ordinary cases, especially where air for ventilation is to be cleaned. This type is, however, especially adapted for filtering air used in manufacturing processes, on the suction inlets to air compressors, for cleaning the air used in cooling electrical machinery, or for cleaning the gas entering internal combustion engines. Notice is sure to be given, by greatly reduced air volume due to clogging, when this type requires cleaning. The thickness and mesh of the fabric are capable of considerable variation, to fit the special requirements of the installation.

Where expense of installation and maintenance is of no importance as compared with results, filters of cotton fiber loosely held within wire frames are in use. The air velocity is kept so low as to be almost imperceptible. The cotton is removed as it becomes soiled, by an attendant whose time is practically fully occupied by this duty. Such an installation must have a very high efficiency.

There are many types of air cleaners which use water. When water is used over a screen of sufficiently fine mesh for the screen to be effective, the water closes the interstices in the screen and reduces the free area. Coke has been used, being held in trays of wire, with water running over the whole. The pores of the coke soon become clogged, and the whole mass becomes slimy and unspeakably foul, when it is a tedious and expensive task to remove it and refill the trays with new material. This type of cleaner also produces considerable resistance to the flow of the

air. Various other expedients have been tried, such as ropes of fiber running as endless belts through a pan of water, the air being drawn between the dripping ropes. With such types there is apparently not enough impinging area, and as with the coke type, the maintenance cost is high.

Gradually there has developed a type of cleaner, in which the air is first drawn through a chamber in which it meets with a spray of water, then through a battery of baffle plates which are so arranged that little if any of the water can pass. Many of the devices and processes of this type of cleaner are covered by patents.

To a large extent, we believe the principle which makes one effective makes all more or less effective. The baffle plates may be vertical or horizontal, curved, angled or hooked, and in their construction lies the secret of the results attained. These water cleaners if they would be economical must have pumps to recirculate the water, as the large quantities used would be expensive if handled but once. If the cleaner is effective, or if there is enough dirt in the air to make it worth while to run the cleaner, this water must be frequently renewed. The cost of running the circulating pump is nominal. The process of securing an intimate contact between the air and water is very important, and there are many patented forms of spray heads and other devices for accomplishing this.

As at present manufactured by a number of firms, this water type of cleaner consists of—

First. A tempering coil, which raises the temperature of the incoming air above the freezing point, or steam coils which heat the circulating water to such an extent that it will not be frozen. It is always advisable that these heaters be automatically controlled.

Second. A spray chamber and tank built of copper, galvanized sheet iron or concrete. In this chamber are spray heads, perforated pipes, overflowing troughs or other devices for securing an intimate contact of the air with the circulating water. In some types the water merely falls from the ceilings; in others, is sprayed in thin sheets at right angles to the air current; in others, falls like rain over the edges of troughs at right angles to the air, or runs over coarse meshed screens.

In some the spray heads open periodically and are automatically flushed out, and in others this flushing must be done manually from outside the chamber. In some, lamentably, it is necessary to shut down and go at each spray with a screw driver. Others are so built that they cannot possibly clog. One device combines the spray chambers with a fan wheel, using centrifugal force for mixing air and water and finally for separating them.

Third. An eliminator, built generally of galvanized iron or of copper. This seems to operate on the same principle as most steam separators in that by sudden changes of direction the air passes on, but the particles of moisture and accompanying dirt impinge on the wet surfaces and drain to the tank through channels provided for the purpose. The shape, size and general design of this part of all air washers seems to be a crucial point. Part of this surface apparently should be passed by the air at high speed, so as to slap the particles of dirt against the wet plates. Part should be passed more slowly, so that as much of the moisture as possible may be deposited.

It seems not inappropriate here to insert some suggestions made by a prominent engineer as to improvement in the water type of air cleaner, as regards both its manufacture and installation. Nearly all the devices now made could be equipped to conform with these suggestions. The expense would be somewhat increased by porcelain enamelled construction, but cleaning would be greatly facilitated, sanitary condition much improved, and everlasting construction attained.

"1. Proper spray chambers, and eliminator chambers, with walls of material impervious to moisture, readily cleaned by hand, the surface to be similar to the vitreous material used for plumbing fixtures.

"2. The eliminator vanes to be made of similar material and made easily removable for cleaning and repairs.

"3. Each spray chamber to be provided with artificial lighting apparatus, so that the operator may observe the condition of the chamber.

"4. The cleaning devices for spray nozzles to be arranged so as to operate from the outside of the washer as readily as the try-cocks of a boiler are operated.

"5. The settling tanks containing the water in the bottom of

the air washers to be made of the same material as the walls of the spray chambers, above described, so as to be easily flushed and cleaned.

"6. Each manufacturer to furnish directions on a metal plate, indicating to the operator the several duties to be performed in order to care for the apparatus properly.

"7. Manufacturers to furnish with every device a reliable dial thermometer (cost about $30) which will indicate the temperature of the spray chamber; also, a reliable dial thermometer which will indicate the temperature of the tempered air chamber, so that the operator can tell whether the automatic temperature control devices are maintaining the proper temperature in each respective chamber, without going into said chambers."

As the gentleman making these suggestions probably has installed as many air washers as any individual not a manufacturer of them, his suggestions should be given consideration.

Every eliminator baffle plate ought to be accessible for cleaning at every joint and crevice. At present, apparently it is impossible thoroughly to scrub down the interior baffles of many makes. Some of the manufacturers have recognized this feature and provided easily removable baffles.

Perhaps one of the greatest fields of activity for water air cleaners or air washers, is along the line of humidity control.

We quote from a paper read before the Brooklyn Medical Society by H. M. Smith, M.D., and printed in the *Metal Worker* in 1905:

"The prevailing practice of depending upon the thermometer as the sole guide in the heating of buildings is not only inadequate and unscientific, but is often misleading. It is not sufficient to know only the temperature if we desire either comfort or health, for the same temperature produces varying sensations of warmth or cold, depending upon the relative humidity at the time existing. It is unscientific and arbitrary to lay down a fixed temperature as a standard for living or sleeping rooms unless the relative humidity is indicated as well.

"At New York and along the Atlantic Coast the prevailing winds during cold periods are usually from the north or northwest, having passed over a dry, frozen area, which has presented

little opportunity for the air to take up moisture. At such times the temperature of the air indoors is allowed to become as high as 76 to 78 degrees in order to feel comfortably warm. Records from steam-heated apartments show that the relative humidity was sometimes as low as 26 per cent., with a temperature of 78 degrees, during a period of very cold weather in January, 1902. The high temperature is necessitated by the chilling of the body by the increased evaporation, evaporation being essentially a cooling process.

"It is needless to say how unhygienic as well as uncomfortable is such a distortion of the proper relationship between temperature and relative humidity. By regulating the indoor relative humidity, we could keep our room temperature much more nearly stationary, irrespective of the temperature outside. But no improvement in indoor atmospheric conditions can be expected until heating engineers and the people they serve realize that with the ever-varying absolute humidity out of doors no system of heating can be made satisfactory if the indoor relative humidity is disregarded. Even thermostatic temperature control will not fill the requirements, for a constant temperature is constant in its effects only if accompanied by a constant relative humidity.

"That we are wasting fuel is evident at once from the unnecessarily high temperature we maintain. The waste is probably greater than is generally supposed. W. M. Wilson in a paper delivered at Milwaukee in 1898 at the convention of weather bureau officials said that about 25 per cent. of the cost of heating is expended in raising the temperature from 60 to 70 degrees, so if we can keep comfortable at a temperature of 65 degrees we shall have saved at least 12½ per cent. of the total cost of heating."

Some of these modern air washers, with the various devices attached governing the temperature and volume of air and water, are able to maintain, automatically, any desired reasonable relation between temperature and humidity, day by day, season by season, and their field of usefulness along this line is, we believe, just begun.

It is not uncommon to hear criticisms by persons interested, of the guarantees imposed in specifications for air washers.

Therefore the following is suggested as being a form of guarantee probably not beyond the bounds of reason, and still one that will insure the owner a fair result for his investment.

a. The machine shall be of sufficient capacity when handling —— cu. ft. of air per minute, to remove not less than 98 per cent. of the solid matter entering the same.

b. To cool the incoming air when recirculating, that the outgoing water and air temperature differences will not be more than a percentage named and guaranteed by the manufacturer, of the incoming water and air temperature differences.

c. In winter automatically to control the absolute humidity of the air leaving the machine within one-half grain of moisture per cubic foot.

We have endeavored to compile some approximate data as to sizes and cost of the different types. These are of necessity approximate. Eight makers of air cleaners were interrogated. Five replied to part of the questions, while the balance refused to answer or feared to divulge trade secrets.

The questions were as follows:

" For quick use in estimating, the following information might be of value if the average of a large number of replies were used. If you will fill out the following blank, an attempt will be made to tabulate the averages for a standard air cleaner to be used, say, in a bank, and handling, say, 25,000 cu. ft. per minute. All replies are of course approximate."

1. Cubic feet of space occupied per 1,000 cu. ft. per minute handled? The answers were 16—22—17½—15—13½.

2. Square feet of floor space occupied per 1,000 cu. ft. per minute handled? The answers were 5.3—1.4—1.68—11—2—1.3.

3. Power consumed by pumps or machinery an integral part of apparatus per 1,000 cu. ft. per minute handled? The answers were 0.06—0.1—0.05—0.075—0.2.

4. Weight of complete apparatus in running condition per 1,000 cu. ft. per minute handled? The answers were 120—150—100—200—75.

5. Cost of apparatus installed in place, under ordinary conditions, per 1,000 cu. ft. per minute handled? The answers were $25.00, $28.50, $24.00, $34.00, $40.00.

It is feared that these answers are too few to make up an average of much quality, and the conditions may be so varied that the answers are not dependable. It would, however, appear that a serviceable air washer of about 25,000 cubic feet capacity per minute can be erected in a space containing about 500 cubic feet, on about 50 square feet of floor and that less than 2 horse power will be required, while the apparatus will weigh somewhere in the neighborhood of 3,600 lbs. and cost probably not more than $800.00.

The committee wishes to acknowledge the suggestions and valuable criticisms of several air washer manufacturers, and to state that the committee having investigated to some extent, appreciates the reasons of these manufacturers for being reticent as to results of tests in their own laboratories.

S. R. Lewis, *Chairman*,
Bert C. Davis,
Thomas Barwick,
R. P. Bolton,
James Mackay.
Committee.

DISCUSSION.

Mr. Kauffman: There are a few questions in this paper that the committee has presented. In the consideration of the air washer No. 1: "Proper spray chambers and eliminator chambers, with walls of material impervious to moisture, readily cleaned by hand, the surface to be similar to the vitreous material used for plumbing fixtures."

I want to say now that is an impossibility with the weight of material to be used in the air washers of the present day. The consumer will not pay the difference in cost to make washers of such materials. In the first place, the iron which the eliminator is made of could not be made of vitreous material because it would buckle or crack, and would not last half as long as the materials that are put in construction nowadays. If we are going to put in material that is everlasting I would recommend as a manufacturer to put in copper for the heavy gauge, and in

nine cases out of ten the consumer will not pay for even the copper.

Now as to readily cleaning and so forth, as to any air washer of good standard manufacture on the market to-day, I will say that I would like to have any member of the Society show me, when the apparatus is in operation, that the baffles will contain any dirt whatsoever; that is, on either the eliminator side or the washer side, if the apparatus is kept in operation. If the apparatus is not kept in operation the dirt will be drawn in from the outside and deposited on those baffle plates. That is not the fault of the manufacturer, it is the fault of the operator; and for that reason if the spray-box is in operation and the eliminator is kept in operation, this will not occur at all.

As to lighting the apparatus, I think that is a very good suggestion.

Referring to the paragraph "Cost of Apparatus," the prices that are given there are so vague and varied that they ought not to go in. For instance, a 2-horse-power motor. I require more than 2 horse power. There are manufacturers that put in less than that, and there are some that put in more. I know most of them are higher horse power for that sized apparatus, pretty nearly double that. Therefore the price cannot be that quoted in this pamphlet. As far as the quality of the apparatus is concerned, that is a different proposition. Now we may make an apparatus partly of copper that will cost three or four times as much. The apparatus may be built of concrete; the fans may be of galvanized iron or may be made of copper. The housing may be made of copper. For instance, we may put in less sprayheads than somebody else. Somebody else's price would be naturally higher than ours.

Mr. Lewis: The part beginning, "For a standard air cleaner, say, in a bank," etc., might be omitted. I would not insist that the prices be stated in the report. I have seen many air washers installed in buildings in which the eliminator vanes could not all be reached and cleaned. Merely spraying water on them will not remove the slime and dirt, it accumulates year after year and becomes very unsanitary. I think the time may come when the baffles will be built of vitreous material, or of enameled cast

iron, perhaps, and each layer will be accessible. Answering Mr. Kauffman, the washer about which our questions were asked was a standard one, and "standard," I take it, does not mean copper.

Mr. Berry: I would like to inquire if any of the members of the Society in actual work, using these air washers for increasing the humidity in the air, have found in their actual practice that the increasing of the amount of humidity has saved any fuel on the plants that are installed? I have heard that some men say it will save a percentage of fuel. Have we had any actual engineering experience among our members which has saved any fuel, and if so, how much?

Mr. Bolton: There is one point as to which I felt somewhat doubtful. That is, the relative percentage of solid matter to be removed, I cannot see how we are to arrive at a conclusion of what 98 per cent. constitutes or includes. The manufacturers of some of these machines are probably better informed than we could possibly be as to what amount of material is in the air when it enters and what 98 per cent. represents. In fact, my suggestion would be that the percentage be left blank, as the other item in that same class is treated.

Mr. Lyle: Mr. Lewis spoke of the eliminator vanes becoming foul. I have been in this business for several years, and I have never seen an eliminator blade that was foul, and I have seen both the horizontal and vertical kinds. I want to ask if the kinds that he spoke of were horizontal or vertical, and if he distinguishes any difference between them.

Mr. Lewis: I had particularly in mind an air washer in a plant installed by ourselves, and it was a vertical one. They would not become foul if the air washer was operated continuously, but they did not operate it continuously. They do not always run the washer when they run the fan.

Mr. Lyle. In a certain paragraph it speaks about using less heat where an air washer is used. But that opinion is a fallacy, and it is one that I am running into right along, finding that people are accepting it as being a fact, and as a result are putting in their boiler plants smaller than they ought to. If any one will figure the amount of latent heat necessary for

evaporation of moisture he will find that the amount saved by carrying a temperature of 65 instead of 70 degrees is more than offset by the amount of heat it takes to evaporate the moisture.

Mr. Kauffman: In regard to the amount of space required for an air washer, if an engineer wants some information on air washers I think he ought to go direct to the manufacturer for it. There are eight or ten washers on the market, and they are all different. Say that the engineer takes the figure here given in the report of 5 square feet of floor space, and an air washer is adopted for this space that takes 11 square feet. Is that the designer's fault or the engineer's fault? I think it is the engineer's fault for adopting that rule. It is all right for the members of the Air Washer Committee to get data together, and I think they have done a great deal, but with reference to that point I think they ought to leave it entirely to the manufacturer, the amount of space that he requires and the amount of horse-power that he consumes, and put the entire responsibility on the manufacturer and not on the engineer, because conditions may change.

With reference to the prices. I can't see where the committee can base anything on those prices as given in that schedule on page 8. Air washers are changing so constantly that the prices that prevail to-day will not prevail in two years from now.

CCXVII.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON HOT-WATER HEATING.

Hot-water heating has been the subject of many papers and topics before the Society during the past fifteen years.

Vol. I. (1895).—At the first annual meeting a paper was presented entitled "A Short Talk on Hot-water Radiators," by J. J. Wilson. In this paper and during the discussion of it the general practice of hot-water heating at that time was brought out.

Vol. II. (1896).—There were no papers on hot-water heating in Vol. II. Topical discussion brought out the opinion that the ideal system of heating for moderate size dwellings was hot water, and that it was more efficient and economical than any other system.

Vol. III. (1897).—A paper, "Arrangement of Mains in Hot-water Heating Apparatus," by Wm. M. Mackay, described the various arrangement of mains used in hot-water heating, and the discussion brought out the general practice of that day.

A paper, "The Relation that Should Exist Between the Steam and Water Ratings of House Heating Boilers," by A. C. Mott, brought out considerable valuable discussion on the subject of hot-water heating.

Vol. IV. (1898).—A discussion of Canadian government specifications for hot-water heating coils brought out considerable discussion on the subject of hot-water heating and the efficiency of coils and radiators.

A paper, "Proportioning Circulating Pipes for Steam and Hot-water Heating Systems," by J. J. Blackmore, gave rules for determining the size of pipes in hot-water heating.

Vol. V. (1899).—The topic, "What Is the Relative Fuel Economy of Heating with Steam and Hot Water?" brought out the statement that hot-water circulation with the same apparatus in the same building, while possessing other advantages, proved one-third more economical in fuel.

Vol. VI. (1900).—No papers or topics on Hot-water Heating appear in this volume.

Vol. VII. (1901).—A paper, "A Low Pressure Hot-water Heating System Receiving Heat from a Steam Boiler," by John Gormly, described a water circulation for heating a small residence, the water being heated by a circulation of hot water through a heater from below the water line of a steam boiler.

A paper, "Proportioning Hot-water Radiation in Combination Systems of Hot-air and Hot-water Heating," by R. C. Carpenter, brought out considerable information regarding ratios, reduced waterways in radiators, and the operation of hot-water apparatus.

A paper, "Volume of Water in Hot-water Heating Apparatus," by Wm. M. Mackay, brought out the statement that a reduced volume of water in radiators, boiler, and mains of a hot-water heating apparatus gave greater efficiency, economy, flexibility, and better results in every way.

Vol. VIII. (1902).—A topic, "What is the Relative Economy of a Hot-water Heating System Using Exhaust Steam to Heat the Water Compared with Using the Exhaust Steam Direct in the Radiators by Aid of Some Air-extracting Apparatus?" brought out the statement that hot-water heating and ventilating apparatus had replaced vacuum steam apparatus in large buildings, proving more efficient and fifty per cent. more economical, requiring less attention.

Vol. IX. (1903).—A general discussion of the topic, "In Proportioning Boilers for Heating Purposes Should the Boiler be Proportioned to the Building to be Heated or to the Radiaton Provided?" brought out the opinion that the boiler should be proportioned to the building to be heated, regardless of the radiation placed.

A discussion of the topic, "Should the Heating Engineer be Expected to Provide Reserve Power in the Heating Boiler After Proper Allowance is Made for Radiation and Piping in Accordance with Manufacturers' Ratings to Insure the Owner an Efficient and Economical Apparatus?" brought out the opinion that many heating boilers were overrated, and that in accepting manufacturers' ratings reserve power should be provided to insure efficiency and economy.

Vol. X. (1904).—"Description of Hot-water Heating Apparatus in the Schioldann Institution, Copenhagen, Denmark," by A. B. Reck. The author described the installation and operation of an especially designed hot-water heating system in which the circulation is accelerated by the admission of steam into the system.

The discussion of the topic, "Has Latest Practice Demonstrated the Advisability of Using Smaller Sizes of Pipe in Hot-water Heating Systems in Greenhouses?" brought out the opinion that better results were obtained by using 2-inch instead of 4-inch pipe, but that modern makes of boilers with deep firepots and ample area for fuel were also necessary for best results.

Vol. XI. (1905).—"Experience with Radiators in the Top Story of a Building," by A. B. Reck. The author shows that by neglecting to figure the roof as an exposure an apparatus failed to heat the top floor of a building, but when the roof was considered and sufficient additional radiating surface placed, the results were satisfactory.

In a paper, "The Circulation of Hot Water," by John S. Brennan, the author described a special method of circulation, the flow and return being connected together through a special valve at one end of the radiator, the other end being blank.

The topic, "Methods of Heating Large Bodies of Water for Public Baths and Industrial Purposes by Steam or Otherwise," brought out the thought that while the heating of water was considered a fixed science, the simple laws governing it were often ignored by the architectural and engineering fraternity, and frequently insufficient power was provided for the work desired.

In a paper, "Residence Heating by Direct and Indirect Hot Water," by E. F. Capron, the author describes the design and installation of a heating apparatus in a large private residence using indirect and direct radiation and having an air filtering arrangement, a tempering coil and thermostatic control.

In a paper, "Notes on the Design of Central Station Hot-water Heating Systems," by J. D. Hoffman, the author de-

scribes the design and operation of a central station hot-water heating system in connection with an electric light plant.

The topic, "Can the Area of Mains in Overhead Systems of Hot-water Heating be Reduced with Benefit?" brought out the statement that the mains in such systems could be reduced twenty-five per cent. below what would be considered good practice in under-feed systems.

The topic, "Vacuum System of Hot-water Heating," brought out the statement that a valve placed on the discharge pipe on the expansion tank of a hot-water system which would permit of a discharge but would prevent the admission of air, gave a better and a longer continued circulation on a falling temperature of water than could be obtained with the ordinary open discharge.

Vol. XII. (1906).—The committee appointed to collect data on hot-water heating at the annual meeting submitted a preliminary report at the summer meeting, outlining their labors, method of procedure, questions to be sent to the members, manufacturers, and fitters in order to accomplish the object of their appointment.

In discussing the paper, "Heat Losses and Heat Transmission," by Walter Jones, the author stated that with the temperature of the water at 170 degrees, it would require sixty-five per cent. more radiation to raise the temperature of a room to 80 degrees in zero weather than would be required to heat it to 70 degrees.

In a paper, "The Elimination of Redundant Parts in the Forced Circulation of Hot Water," by Arthur H. Barker, the author described a system of forced circulation in which the use of pumps was done away with and the circulation increased with the admission of steam; he claimed simplicity of operation, better results, and the use of smaller mains than is usually placed in this class of work.

Vol. XIII. (1907).—In a paper, "Comparison of Quick Circulating Systems of Hot-water Heating," by C. Guitton, the author gave a description of the construction and operation of the several European systems in which the circulation is accelerated by the introduction of steam.

In a paper, "Formula for Pipe Sizes in Hot-water Heat-

ing," by Oliver H. Schlemmer, the author described his method of obtaining the sizes of the mains, risers and connections in hot-water heating systems.

Vol. XIV. (1908).—The topic, "The Effect of Increased Pressure in Hot-water Heating Systems," brought out the statement from one of our members who was a strong believer in heat generators attached to hot-water heating systems, that after he had placed some fifteen or twenty such systems he completed an apparatus according to the reduced sizes of pipes called for, and while waiting for the generator to arrive the owner insisted on having heat, and he undertook to give him what he could without the generator, and was surprised to find that the apparatus worked equally as well without the generator as the others which he had placed did with it; that when the generator arrived he placed it and found no improvement in the circulation, and since that time he had placed many apparatus with the same sizes and arrangement of pipe without the use of the generator and obtained equal results.

The topic, "The Comparative Value of Forced and Gravity Circulation in Residence Hot-water Heating Systems," brought out the opinion that where water could be circulated by gravity it was a mistake to employ any mechanical means, and that in fired apparatus anything that increased the temperature 140 to 180 degrees also increased the temperature of the escaping gases, making the system more wasteful in fuel without any special advantage.

In addition to this, much information on the subject of hot-water heating is contained in the several reports presented by the committee appointed to collect data on this subject.

The advantages of the system in its many different applications to all classes of buildings in this country, Canada and Europe would lead the Committee to say that we should have many additional descriptions of successful installations in our proceedings.

Respectfully submitted,

WM. M. MACKAY,

Chairman.

CCXVIII.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON STEAM HEATING FOR RESIDENCES AND SMALL BUILDINGS.

Your Committee of Review on Steam Heating for Residences and Small Buildings beg to report as follows:

We have studied the transactions of the Society beginning with Vol. I., 1895, to Vol. XIII., 1907, and give a review of the papers presented and topics discussed pertaining to this subject.

We find that a number of the papers presented and topics discussed herein referred to are matters referred to by other review committees, but are of the opinion that they should be included in this report to make it complete.

The following is an index of subject-matter as appearing in the Transactions, by volume.

VOLUME I.

Testing of Steam Radiators, by Professor Carpenter, pp. 98 to 145. Literature on Heating and Ventilating, by Hugh J. Barron. A list of literature, a number of books and essays covering this subject, pp. 174 to 177.

TOPICAL DISCUSSIONS:

TOPIC No. 4: "Regarding necessary size of steam risers—both flow and return," pp. 232-36.

VOLUME II.

TOPICAL DISCUSSION:

TOPIC No. 1: "Discussion by MR. Quay on heating a house with steam at or below atmospheric pressure," pp. 209-10.

TOPIC No. 6: "The advantages of the one-pipe system over a two-pipe or a two-pipe relief system," pp. 222-25.

TOPIC No. 15: "What quantity of water should sectional house-heating steam boilers contain in proportion to their grate and fire surface?" pp. 232-34.

TOPIC No. 17: "Which are the most effective, float or expansion automatic air valves?" p. 235.

TOPIC No. 20: "What should be the proper form and area of chimneys for house-heating boilers in proportion to their grate surface?" pp. 235-40.

TOPIC No. 28: "What is the cause of priming or foaming in house-heating boilers?" pp. 246-47.

VOLUME III.

Method of Proportioning Direct Radiation, by R. C. Carpenter, pp. 73 to 90.

VOLUME IV.

Some experiments in Steam Circulation, pp. 101 to 113, by John Gormly.

Single Pipe Low Pressure Steam Heating Systems, by Mark Dean, pp. 195 to 207.

VOLUME V.

Heating with Steam at or Below Atmospheric Pressure, by J. H. Kinealy, pp. 241 to 264.

TOPICAL DISCUSSIONS:

TOPIC No. 1: "What is the safe velocity for steam to travel in steam mains and risers? Is a half-inch valve large enough on the steam supply of small radiators?" pp. 276-82.

TOPIC No. 2: "What is the relative fuel economy of heating with steam or hot water of low pressure and temperature?" pp. 282-87.

VOLUME VI.

The Rating of Steam and Hot-water Boilers for Heating Purposes, by Jas. Mackay, pp. 160 to 173.

TOPICAL DISCUSSIONS:

TOPIC No. 4: "When heating by direct radiation, should the radiators be placed close to an outside or an inside wall? And if placed by an outside wall, should they be placed between or before windows?"

VOLUME VII.

Theory of Low-pressure Steam Heating, by G. Debesson, Paris, France, pp. 58 to 96.

Volume VIII.

An interesting paper on Loss of Heat Through Walls of Buildings (being a discussion of a paper in this volume by A. B. Reck of Copenhagen), by R. C. Carpenter, pp. 96 to 105.

TOPICAL DISCUSSION:

Topic No. 1: "The Tudor system of steam heating as compared with the French system," pp. 148-60.

Volume IX.

Heating Boiler Development, by H. J. Barron, pp. 153 to 159.

Capacity of Cast-iron Sectional Steam Boilers, by J. J. Blackmore, pp. 160 to 178.

TOPICAL DISCUSSIONS:

Topic No. 2: "In proportioning boilers for heating purposes, should the boiler be proportioned to the building to be heated or to the radiation provided?" pp. 191-99.

Topic No. 5: "Should the heating engineer be expected to provide reserve power in the heating boiler after proper allowance is made for radiation and piping in accordance with manufacturer's ratings, to insure the owner an efficient and economical apparatus?" pp. 204-11.

Topic No. 6: "Are there any advantages in the use of vacuum systems of steam heating for residences?" pp. 211-14.

Description of a Low-pressure Steam Heating System which Proved Defective in Operation, by John Gormly, pp. 238 to 258.

TOPICAL DISCUSSIONS:

Topic No. 1: "What is the proper method of rating steam and hot-water boilers for heating purposes?" pp. 289-93.

Topic No. 2: "The relation of space between sections to the efficiency of steam and hot-water radiators," pp. 293-98.

Volume X.

To Figure Heating Work Accurately, with a table showing the losses in British thermal units for various surfaces, by Charles F. Hauss, pp. 114 to 127, with A. R. Wolff's Table of Transmission of Heat in Buildings, on p. 128.

The Necessity of Moisture in Heated Houses, by R. C. Carpenter, pp. 129 to 136.

TOPICAL DISCUSSIONS:

Topic No. 5: "Are all types of sectional cast-iron boilers adapted for steam heating?" pp. 175-76.

Volume XI.

Test of a Steam Heating Boiler, by R. C. Carpenter, pp. 120 to 123.

TOPICAL DISCUSSIONS:

"The requirements of house-heating boilers using bituminous coal," pp. 140-43.

Topic No. 1: "Can pipe size for risers and radiator connections off risers be reduced?" pp. 254-59.

Volume XII.

Size of Return Pipes in Steam Heating Apparatus, by Jas. A. Donnelly, pp. 108 to 121.

A New Vapor-vacuum System of Steam Heating, by Jas. A. Donnelly, pp. 122 to 129.

TOPICAL DISCUSSIONS:

Topic No. 3: "The advantage of automatically venting the extreme ends of steam mains in the basement on low-pressure gravity steam-heating apparatus, and the proper mode of connection," pp. 206-7.

Topic No. 1: "The comparative relation between the completeness of air removal and the efficiency of steam radiators," pp. 313-25.

Topic No. 8: "The effect of the size of the mains on the height of the water line in the different parts of a gravity steam-heating system," pp. 333-41.

Topic No. 9: "The relative economy in fuel of steam, vapor, vacuum, and hot-water heating for residences," pp. 341-50.

Topic No. 15: "The durability of different kinds of nipples for connecting radiator sections relative to the material, and the capacity to withstand shocks and strains, also the effect on boiler connections," pp. 358-61.

Volume XIII.

Standard Sizes of Steam Mains, by Jas. A. Donnelly, pp. 43 to 53.

The Carrying Capacity of Pipe in Low-pressure Steam Heating, by William Kent, pp. 54 to 73.

The Combined Pressure and Vacuum System of Steam Heating, by Geo. D. Hoffman, pp. 223 to 247.

TOPICAL DISCUSSIONS:

Topic No. 7: "The benefits derived from the use of fusible plugs in cast-iron steam boilers," pp. 296-97.

We have refrained from commenting on the different papers and discussions, as the opinions of the members are at wide variance in some matters. We also find that some of the data and practices advocated in some of the earlier Transactions have been altered in the later Transactions to conform to the more modern practices based on more recent tests and experiments.

The committee finds that low-pressure steam heating is not as generally used or advocated for the heating of residences and small buildings as is hot water, and find the arguments against steam and in favor of hot water for this class of buildings to be quite general.

The principal advantages of the low-pressure gravity system of steam heating for residences and small buildings are:

First. Low cost of installation, being from 25 per cent. to 50 per cent. less than hot water.

Second. Economy of space required for the radiators.

Third. The quickness of results, it requiring much less time for warming a building that is warmed intermittently or one in which the boiler is run with a banked fire during the night.

Fourth. Less liability of freezing, which is an important consideration especially when indirect radiators are used.

Fifth. Less liability of damage caused by leaks.

We find great room for improvement in low-pressure steam heating for this class of buildings, some of the disadvantages of which are:

First. Lack of control of the radiator to maintain the temperature of the different rooms at the proper degree.

Second. A low range of temperature within the apparatus, usually between 212 and 240 degrees, this usually being insufficient to suit external temperatures.

Third. Economy of fuel consumed, and labor expended in the care of the apparatus on account of the above-mentioned reasons.

Your committee is of the opinion that some of the later systems of low-pressure steam combined with the vacuum system overcome most of the disadvantages mentioned above of the low-pressure steam system for this class of buildings, reference to these systems being included in the index.

CHAS. F. NEWPORT,
Chairman.

CCXIX.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON FURNACE HEATING.

The undersigned was appointed as a special committee of one member to review the data relating to the furnace heating of buildings in the Society proceedings and report at the annual meeting of the Society. The following report is therefore submitted to the membership with the hope that it may prove interesting and beneficial. The views expressed and the data presented are based only upon material taken from the Transactions bearing upon this subject.

During the first thirteen years of its existence, the American Society of Heating and Ventilating Engineers took up for discussion the topic, Warm Air Furnace Heating, in some way or another thirty-three times. This averaged about two and one-half times each year, that the subject, in some one of its many phases, was up for discussion. Seventeen papers were presented, and sixteen oral discussions. Of the papers, six contained sufficient data to allow them to be designated as tests, three were descriptions of installations, and the remaining eight were opinions, data and theory. Fourteen of the papers were written by members and three were written by non-members of the Society.

The features of the subject which were discussed the most thoroughly, were: Ratio of the grate area to the heating surface in the furnace; Air space inside the outer casing of the furnace; Circulation of the air in the furnace; Shape and size of the fire pot; Manner of taking leaders from furnace bonnet; Construction of warm air leaders and flues; Location of registers; Velocity of air through furnace, leaders, flues and registers; Recirculation of air, partial recirculation of air, or the use of all fresh air; Temperatures of furnace walls, flue gases,

and air entering rooms; Quantity of heat radiated from 1 square foot of heating surface; Ratio of the area of the fresh air ducts to the leader area; Ratio of the leader areas to the grate area; Ratio of the leader areas to the register areas; and Calculation of heat losses from buildings.

The opinions, representing current practice with reference to the above subjects, that are most logically presented to the Society and best borne out by reports on tests, seemed to be as follows:

Furnace.

The fire pot should be cylindrical or very slightly conical in shape. Some advocated an inverted conical fire pot, *i. e.*, with the larger diameter at the grate. It should be large enough to hold fuel for an eight hour fire, and the ratio of the heating surface to the grate area would approximate twenty-five to one (25:1). The grate should not be required to burn more than 4 pounds of coal per hour. A corrugated surface for the fire pot seemed to be favored. The temperature in the furnace should be high in order to provide for complete combustion. It was considered that high temperatures were not objectionable, so long as the exhaust gases had a low temperature, and so long as sufficient air is circulated over the heating surface. In no case should the temperature of the chimney flue gases be higher than 400 degrees F.

The air space between the casement and the heating surface was thought to require a cross-sectional area equal to or greater than the combined cross-sectional area of all leaders connected to the furnace. With regard to the circulation of the air in the furnace, if possible, the cold air should enter the heating space in such a way as to first come in contact with the surface heated by the exhaust gases as they escape into the chimney flue, and should pass over the hotter portions of the furnace last. This gives a low temperature to the exhaust gases and a high temperature to the circulating air. The velocity of the air over the heating surface does not seem to be fully settled, but all are agreed that, should it be such, the air passing through the register will have a temperature less than 140 degrees Fahrenheit.

The warm air leaders should be taken off near the top of the casement at an angle of about forty-five degrees.

One square foot of heating surface should give up approximately 2,500 B. T. U. per hour.

Fresh Air Duct.

The fresh air duct should be air and water tight if placed under the cellar floor. When there is room it is preferably placed overhead in the basement, and drops to the floor near the furnace. The cross-section of the duct should be 80 per cent. of the combined area of all the warm air leaders, and it should take its supply from a point where the air will not be contaminated with dust, gases or malodors. If this is not possible a fresh air room should be provided and screens and deflectors used to rid the air of its dust. In nearly all residence work the plan includes the recirculation of a part of the air passing through the furnace and this necessitates proper dampers and connections in these lines. The manipulation of these dampers should provide for the recirculation of any desired proportion of the air.

Leaders and Flues.

The best practice seems to favor double walled leaders and flues with asbestos between. The use of thin sheets of asbestos on the outside of a single pipe is of doubtful value.

Abrupt changes in the direction or the size of a pipe should be avoided and the greatest possible rise with the least number of turns for the basement leaders should be provided.

The velocity of air in leaders varies from 250 feet per minute, for those leading to the first floor, to 500 feet per minute, for those leading to the second and third floors.

The cross-sectional area of all leaders should total between 1.1 and 1.5 times the grate area.

Registers.

The area of the net heat register is from 1.1 to 1.25 times the area of the pipe leading to it. Ordinary practice places the heat registers either in the floor or at the floor line. A much higher

velocity in the warm air flues could be allowed by placing the registers in the walls above the heads of the occupants.

Ventilating registers should be placed at the floor line, and are in practice the same size as the warm air registers, although the theoretical size would be somewhat less. The flues leading from the ventilating registers are so arranged as to take the air back to the furnace or to the outside of the building and must be supplied with necessary dampers. The area of these flues will be either that of the warm air flues or 80 per cent. of that area.

Heat Losses in Buildings.

This part of the furnace work is common to all other types of heating also, and should be more complete. The following, however, is merely that given under the furnace work.

In calculating the heat lost from a room, find the exposed wall area and add one-fourth of this to the actual glass area. Multiply this sum by 75 for rooms having south exposure where the climate has a temperature seldom less than 0 degrees F. For other exposures than a south exposure this multiplier will vary from 75 to 100.

This rule is based on the following assumptions: The loss of heat, by radiation, from 1 square foot of glass, is 1 B. T. U. per hour for each degree difference between the inside and the outside temperatures. The loss through the average wall is one-fourth of that for glass. The floors and ceilings between heated rooms and unheated rooms may be taken as having one-tenth the loss of glass area.

In case air is used for ventilation, 55 cubic feet may be considered as carrying off 1 B. T. U. for each degree difference in temperature between the room temperature and the outside temperature. Similarly 55 cubic feet of air will bring 1 B. T. U. into the room for each degree difference between the temperature at the register and the room temperature.

The following is a review of each volume separately.

Volume I.

No papers on the subject were presented.

TOPICAL DISCUSSION:

No. 13: "What is the proper proportion for cold-air inlets to hot-air furnaces?"

Mr. Wilkinson mentioned lack of data and there was no discussion.

No. 20: "Are mushroom registers under auditorium seats advisable, or are all floor entrances for warm air objectionable?"

There was some discussion and the same opinion expressed, that all warm air should be brought in above the dust line.

Volume II.

"Forced Blast Heating with Furnaces."

Paper by Mr. G. W. Kramer (non-member).

The author of the paper briefly describes the first installation made by him in which he uses warm air furnaces and forced blast. The system was installed in a large church and tested in severe weather, giving the best of satisfaction. The fan was driven by an electric motor, and was so placed that the air was forced over the heating surfaces rather than being drawn over.

Furnaces having corrugated heating surfaces were used, with extra plates, a few inches from the furnace walls to catch the radiated heat and transfer it to the air being warmed. The air was passed over the heating surface at a velocity greater than 1,000 feet per minute and the temperature of the furnace walls kept below a red heat.

The paper was discussed very energetically by warm air, hot water and steam heating advocates. The paper and discussion was of considerable value to the Society Transactions.

TOPICAL DISCUSSION:

No. 1: "Judging from present standards, what is the ideal system of heating for moderate sized dwellings?"

In the discussion, the use of warm air furnaces was briefly mentioned.

No. 23: "In what location are the best results obtained from hot-air flues—outer walls or inner partitions?"

Discussion brought out the following opinion: neglecting the loss of heat from the flues, due to being located in the outer walls, and considering only the even distribution of warm air in the room, the air should enter the room and leave the same from the outer wall. Of course this plan would necessitate the insulation of the flues. This plan is, of course, contrary to current practice, because of the loss of heat from the flues when located in outer walls, thus lowering the velocity to such an extent as to nullify the effect of the draft in many installations.

VOLUME III.

"Determining the Volume of Air Passing Through a Register in One Minute."

Paper by Prof. J. H. Kinealy (member).

Prof. Kinealy reported the results obtained from a number of tests from which he developed a formula giving the volume in terms of the reading of an anemometer, and the area of the face of register. The formula and its application are as follows: Let V be the volume in cubic feet of air passing through the register per minute; v the average velocity per minute as determined by the anemometer held about one-half an inch from the face of the register; A the area of the face of the register in square feet; and x a factor to be determined. Then $V = xvA$. If by a series of experiments we can determine V, v, and A for a given register we can then find $x = \frac{V}{vA}$. Having once found x this may be used to find V when v and A are known. It is probable that x will vary slightly with v and with the ratio of the area of the opening in the register to the area of the face.

RESULTS OF THE EXPERIMENTS

No. of Test.	Value of x.		Average velocity of air at face of Register.
	V determined from Pipe.	V determined from Box.	
1	0.85	....	109
2	0.67	0.80	194
3	0.80	0.92	168
4	0.65	....	101
5	0.63	0.78	132
6	....	0.81	195
7	....	0.76	147

TOPICAL DISCUSSION:

No. 3: "What is the highest temperature that can be maintained in a hot-air furnace without detriment to the air passing through it?"

The topic as expressed assumes that air heated to a high temperature is unfit for ventilating purposes. Some contend that high temperatures in the furnace will not affect the quality of the air. The discussion seemed to show, that with plenty of air supplied to the heating surface, the temperatures might be very high, and that the higher temperatures would cause a more rapid circulation and in a measure remove the danger of overheating the air.

No. 6: "Have the recent changes in the form of hot-air furnace construction increased their efficiency?"

Discussion showed that the efficiency of a warm air furnace may be increased by increasing the ratio of the heating surface, by the manner of admitting the cold air into the furnace, by changing the elevation of the leader pipes, by the size of the warm air flues and by the size of the registers.

One speaker said that the manufacturers were at sea in regard to grate areas, heating surfaces, capacity of grates and amount of air to be circulated.

No. 15: "What is the maximum velocity at which air may be introduced to rooms without producing noticeable drafts?"

The speaker thought from 300 to 500 feet per minute would be satisfactory without diffusers, and with diffusers, from 800 feet per minute upwards. In case of high velocities the air should be admitted above seven feet from the floor line.

VOLUME IV.

No material.

VOLUME V.

"Heating a Private Residence with a Warm Air Furnace."

Paper by Mr. B. H. Carpenter (member).

This paper describes the heating of a residence having twenty rooms, in three floors. The volume of the house was 38,800 cubic feet. The furnace had a grate 30 inches in diameter and

107 square feet of heating surface. The fresh air duct had an area of 12 square feet which would provide 216,000 cubic feet of air per hour at a velocity of 300 feet per minute. Large leader pipes and risers were used, the warm air for several rooms being taken from one riser. The writer defended this practice, having frequently used the plan, but he did not give any figures from which conclusions could be drawn. He did not give glass or wall area, or calculated heat loss.

The discussion of the paper indorsed the plan of few leaders and risers, one riser leading to one or more rooms.

Mr. Carpenter was compelled to defend the large area of the fresh air duct by saying that it would be needed in mild weather.

TOPICAL DISCUSSION:

No. 8: "What is the practical experience as to the loss of heat from hot-air flues, especially when such must be located in outer walls?"

A written discussion by Mr. H. Eisert (member).

Mr. Eisert presented a very complete written discussion with formulas for calculating the drop in the temperature of air while passing through leaders and flues. These formulas are well worked up, but are too long to be presented in this review.

Volume VI.

"Dangerous Air Ducts."

Paper by Mr. John Gormly (member).

Mr. Gormly argued the necessity of correct installation and care of fresh air ducts. As far as possible, the air ducts should be so arranged that a little carelessness could not destroy their efficiency. In every case the possibility of allowing contaminated air to enter fresh air ducts must be avoided. The discussion emphasized the need of care in the use of screens and air ducts.

Volume VII.

"Proportioning Hot-water Radiation in Combination Systems of Hot-air and Hot-water Heating."

Paper by Prof. R. C. Carpenter (member).

Prof. Carpenter told of his experience with combination systems of warm air and hot-water heating, and of the difficulty in proportioning the heating surface for the hot water to the size

of the furnace. He gave results from a comparative test as follows:

	Test No. 1.	Test No. 2.
1. Coal burned per hour in pounds	6.65	14.65
2. B.T.U. supplied per minute	1,571	3,470
3. " absorbed by water per minute	459	742
4. " " " air " "	653	644
5. Ratio of items 3 and 4	1:1.4	1:.87
6. Average velocity of air (ft. per minute)	463	534
7. Pounds of air per minute	10.79	9.94
8. Total efficiency of furnace (per cent.)	79	40

The above results are from the same furnace on two different days and show that different laws apply to water and air when used as heat carriers. This demonstrates the fact that it is impossible to build a furnace for combination heating which will give desired results under varying conditions of firing. The velocity of air increases with a rise in temperature and its density decreases, but these same ratios do not apply to water.

"Hot-air Furnace Heating."

Paper by Mr. C. G. Folson (member).

Mr. Folson described plans for heating a house of 14 rooms having outside dimensions of 36 x 56 feet. No glass and wall areas were given. The area of the glass was apparently not used in designing the system. The volume of the house was 30,000 cubic feet. The furnace was of the tubular type, with 26-inch fire pot. The pit under the furnace was 24 inches deep with a cold air duct having an area of 720 square inches. There were 14 warm air leaders from the furnace, 3 12 inches, 3 10 inches, and 8 9 inches diameter. The leaders had a rise of 1 inch in 10 feet. The total cross-sectional area of the leaders was 1,077 square inches. The warm air flues were 4 inches x 12 inches, double walled with asbestos between. There were return ducts from each room to cold air intake. The furnace had used less than 10 tons of hard coal from October 29 to May 1, and had given perfect satisfaction.

VOLUME VIII.

TOPICAL DISCUSSION:

No. 4: "What is the advantage or disadvantage of broad grates with shallow firing over deep fireboxes and concentrated fires on small grates in hot-air furnace heating?"

Several speakers discussed the topic and Mr. Oldacre told of some tests he had made. The results of these tests showed that

56 pounds of coal in deep fires did the work of 140 pounds in shallow fires in a small warm air furnace.

Lack of data on the subject was mentioned.

VOLUME IX.

"Furnace Heating and Ventilating System in the Public Library of Ilion, N. Y."

Paper by Mr. W. H. Switzer (member).

Mr. Switzer previously installed the system, and here gave a full description of it and the building in which it was installed. The library had two rooms, the main room and the reading room. Two furnaces were used, one being placed near the north side and one near the south side. One leader ran from the south furnace to the north room and one from the north furnace to the south room. This plan allowed either one or the other of the furnaces to be used in mild weather.

The following are the data given:

Main Room	Cubic contents in cubic feet	43,750.
	Wall area (exposed) in square feet	3,045.
	Glass area in square feet	355.
Reading Room	Contents in cubic feet	16,350.
	Wall area in square feet	1,976.
	Glass area in square feet	174.
Total	Contents in cubic feet	60,100.
	Wall area in square feet	5,031.
	Glass area in square feet	529.
Two furnaces, each having 22-inch grate; total grate area in square feet		5.3
Total hearing surface in square feet		176.
Ratio of heating surface to grate area		34:1
Total cross-sectional area of leaders in square inches		1,033
Total cross-sectional area of cold air ducts in square inches		640
Equivalent glass area in square feet		1,367
Heat loss per hour B.t.u		95,690
Average coal burned per year for 10 years in tons		20
Velocity of air in cold air ducts, feet per minute		350
Velocity of air at registers, feet per minute		300 to 380

The warm air leaders were tapered to keep the velocity constant and to prevent eddy currents

Discussion of the paper brought out the statement that the building was being heated more economically by warm air than could be done by steam or hot water.

"Test of Hot-air Gravity System of Heating and Ventilation in a School Building."

Paper by Mr. B. H. Carpenter (member).

The paper gives a description of the system and the results from two tests. The building had eight rooms each 34 x 26 x 12 feet. Ventilation was produced by warming the air in a ventilating stack having an area of 15 square feet. The warm air flues to the first floor rooms had an area of 5 square feet, and those to the second floor rooms had an area of 4 square feet. The warm air registers were 8 feet above the floor and the vent

registers were at the floor. The total heating surface was 229 square feet, and the ratio of the heating surface to the grate was 45.1.

The data from the test showed satisfactory temperatures and volumes of air in the rooms tested and, assuming 10,000 B. T. U. per pound of coal, gave an efficiency in the furnace of about 59 per cent.

TOPICAL DISCUSSION:

No. 9: "The Relative Importance of Grate and Heating Surface in Proportion to Exposed Surface in Furnace-heated Buildings."

Discussion showed the lack of definite data and an appeal was made to the members of the Society to collect and submit such data.

No. 10: "The Relative Value of Fire Pots and Other Surfaces in Hot-air Furnaces."

Discussion favored fire pots with vertical sides or, if tapered, those having the large diameter at the bottom.

Volume X.

"The Battery System of Warm-air Heating."

Paper by Mr. C. E. Oldacre (member).

This system consisted of a battery of two furnaces, each having a 21-inch grate. The furnaces were set 12 inches apart and connected at the top by the warm air dome which was built so as to provide an 18-inch clear space over the furnaces. There were sixteen warm air leaders as follows: 3 7 inch, 5 8 inch, 5 9 inch, 1 10 inch, and 2 12 inch in diameter.

The principal reasons for using two 21-inch furnaces instead of one large one were, first, the ratio of the heating surface to the grate area is larger in a small furnace; second, in mild weather one furnace could be used alone and satisfactory control was much more easily secured than with one large furnace at such times.

In designing the system the heat loss for each room was obtained, taking into account the glass and wall area. In determining the size of the leaders and warm air flues for each room,

the length of the leader, its course in regard to abrupt turns and rise per foot, and the exposure of the room were all taken into account.

An examination of the entire house while the system was in use showed an even temperature throughout and the plant was giving perfect satisfaction. The more important data are:

Contents of house in cubic feet	33,744
Wall surface in square feet	2,853
Glass surface in square feet	731
Equivalent glass area in square feet	1,537
Grate area in square feet	4.8
Heating surface in square feet	300
Ratio of heating surface to grate area	62.5:1
Cross-sectional area of leaders, in square inches	983
" " " " fresh air pipes in square inches	700
Ratio of items (8) and (4)	1:225
" " " (5) " (4)	1:320
" " " (6) " (4)	1:5

"Advance Methods of Warm Air Heating."

Paper by Mr. A. O. Jones (non-member).

This paper gives a description of a warm air system that the writer installed in a large residence. In this plant it was quite noticeable that the design provided large areas for the grate, the heating surface, the air space between the furnace proper and the casement, and the warm air leaders. Another noticeable feature was the arrangement of the warm air flues and ventilating flues. One leader supplied air for more than one register; *i. e.*, a first floor and a second floor register, the current of air being divided after it left the leader and had started on its vertical rise. A damper with the first floor register controlled the amount of air deflected through that register.

The volume of the house was 23,548 cubic feet, and although the temperature outside dropped to —20 degrees the system was at all times adequate. It had averaged less than 10 tons of coal per winter.

The principal data are to be found below:

Space heated in cubic feet	23,548
Wall area in square feet	2,267
Glass area in square feet	504
Equivalent glass area in square feet	740
Number of rooms heated	13
Number of basement pipes (leaders)	7
Cross-sectional area leaders in square inches	740
" " " fresh air pipes in square inches	592
" " " return flow flues in square inches	740
Area of air space in furnace in square inches	768
Diameter of grate in inches	30
Area of grate in square feet	4.65
Heating surface, in square feet	124
Ratio of heating surface and grate area	27:1
" " " " to volume of house	1 square foot to 193 cubic feet
" " " " equivalent glass area	1:60

TOPICAL DISCUSSION:

No. 4: "What is the prevailing practice in proportioning water heaters in hot-air furnaces to the work to be done?"

Mr. Snow allowed from 15 to 20 square feet of radiating surface for each square foot of heating surface above the fire. For coils in the fire, from 40 (to 50) to 1. A combination having a part of the heating surface in the fire pot and a part above it, is recommended.

VOLUME XI.

"Gas as a Fuel for Hot-air Heating."

Paper by Mr. R. S. Thompson (member).

This paper discussed the use of natural gas as a fuel for furnaces, and the adaptation of furnaces to the burning of natural gas. The principal points demanding attention are: The burner, the air supply, the heating surface, and the disposition of the water of condensation. Discussion on the paper pointed out its value to anyone building furnaces for burning natural gas.

"Possibilities in Heating with Hot Air."

Paper by Mr. R. S. Thompson (member).

This is a comparison of the relative efficiencies of warm air and hot water or steam heating. From a theoretical standpoint a higher efficiency is argued for furnace heating, because the air enters the heating space of the furnace at a low temperature, and by passing this cool air first over the surfaces warmed by exhausting gases their temperature may be reduced quite low and thus a high efficiency is secured in the furnace. In case of warm air heating the initial temperature is from 70 degrees F. down to zero or below. The speaker urged large cold air ducts, ample heating surface with plenty of surrounding air space, and a positive circulation of air in the system. The speaker cited tests in which the exhaust gases were at a temperature of 120 degrees F. when the furnace was delivering 1,000 cubic feet of air per minute at a temperature of 210 degrees F.

TOPICAL DISCUSSION:

No. 3: "Grate and Heating Surface, and Their Relation to Contents and Exposure in Furnace Heating."

The only ratio given in the discussion was that of grate area to equivalent glass surface, which was stated as 1 square inch to 15 square feet or as 1:2160.

VOLUME XII.

"Report of Committee on Collection of Data on Furnace Heating."

The following questions were sent out by the Committee and two sets of answers were received.

1. What rule or formula would you use for obtaining the following:

Heat loss by conduction and radiation from buildings through walls, windows, etc.

Heat lost by warm air escaping from the building.

2. The sum of these two losses is the total heat that must be supplied to the circulating air by the furnace. What quantity of air should be passed over the furnace in order to absorb this amount of heat? Have you a rule or formula for obtaining this?

3. Suppose the outdoor air is zero and the temperature of the hall or other part of the house from which air may be drawn into the cold air box is 60 degrees F., what proportion would you draw from the outside and what from the inside in an ordinary dwelling house of 8 to 12 rooms?

4. How would you calculate what would be the maximum temperature of air passing over the furnace? Do you consider this the most advisable temperature of air at the outlet?

5. What rule or formula have you for proportioning the extent of the heating surface of the furnace to the maximum quantity of heat to be given to the air by the furnace?

6. What rule have you for the diameter of the fire pot, depth of fire pot, diameter of grate, and for maximum rate of combustion per square foot of grate area per hour?

7. What rule have you for determining area of pipe admitting cold air from outdoors? If pipe is used for inside circulation, what then?

8. What rule have you for the area of heater pipes leading from furnace to first, second, and third floors?

9. What rule have you for the sum of the areas of all air outlets of the furnace?

10. What rule have you for the area of the registers?

11. What preference have you to the location of registers in different rooms?

12. What is your rule for area of foul air outlet from house?

13. What method have you for insuring entrances and circulation of warm air in every room, particularly the side of the house exposed to the strongest cold winds?

14. What is your opinion of warm air heating where a positive means of circulation is used, including both inlet and exit pipes for every room? Do you know of any examples and where?

Answers by Mr. Wm. G. Snow.

1. Heat loss = H = 85 times equivalent glass surface.
   1.25 times H for north or west exposure.
   1.15 times H for east exposure.
   Heat loss due to ventilation = 1.25 times cubic feet of air lost.

2. 1 B. T. U. will heat .375 cubic feet of air from 0 degrees to 140 degrees.

3. Plan to recirculate air or not as occasion demands.

4. The temperature of the hot air should be from 120 degrees to 140 degrees.

5. One square foot of heating surface should give off 2,500 B. T. U. per hour.

6. The ratio of grate area to heating surface will be 1:15 or 1:20. Amount of coal burned is not more than 5 pounds per square foot per hour.

7. Area cold air duct equals .75 times area of leaders.

8. No answers.

9. Ratio of area of leaders to grate area = 1.25:1.

10. Area of registers = 1.1 or 1.25 times area of pipe.

12. Ventilating flues should provide four changes of air per hour.

14. Return air ducts aid in heating exposed rooms.

Answers by Mr. Bird (non-member).

1. Same as above.

2. Same as above.

3. Had not used recirculation of air.

4. $\dfrac{\text{Total B.T.U. from coal}}{\text{Cubic feet of air} \times .0205}$ = temperature rise in degrees.

5. Ratio of heating surface to grate area = 12:1.

6. Assuming 8000 B.T.U. per pound of coal and 5 pounds of coal burned per hour, $\dfrac{\text{Heat loss}}{40{,}000}$ = grate area.

7. No answers.

8. Equivalent glass surface = glass area + $\frac{1}{4}$ wall area + $\dfrac{\text{ceiling and floor area}}{20}$.

Add 10 per cent. for exposed places $.85 \times \text{E.G.S.} = H$. $\dfrac{H}{1.1}$ = volume of air per hour = V.

$\dfrac{V}{60 \times V}$ = area of leader. V = velocity per minute = 280 feet for first floor, 400 feet for second, and 500 feet for third.

10. 1.25 times area of hot air pipe = area of register.

14. Had not used vent pipe for each room.

"Fads and Fallacies of Hot-air Heating."

Paper by Mr. R. S. Thompson (member).

This is a discussion and a criticism of some present methods of installation; also, a description of some unusual work in warm air heating by the author.

"An Improved Application of Hot-air Heating."

Paper by Mr. A. O. Jones (member).

A discussion of the use of one leader for supplying warm air to two or three rooms, one on each floor.

TOPICAL DISCUSSION:

No. 11: "The Proportion of Heating and Grate Surfaces in Hot-air Furnaces."

Prof. Kent gave 25:1.

VOLUME XIII.

TOPICAL DISCUSSION:

No. 1: "The Relative Efficiency and Velocity in Two Warm-air Pipes, One Having a Vertical Rise of 18 Inches to a Round Elbow Supplying a Pipe Running Horizontally for 10 Feet, the Other Having a Uniform Upward Inclination of 18 Inches in 10 Feet."

The discussion favored the opinion that in case of low velocities there would be no difference, but with high velocities the inclined pipe would have the better efficiency.

No. 2: "The Difference in Capacity to be Provided in Warm-air Pipes where Air travels at Different Velocities."

No discussion.

No. 3: "The Relative Size of Hot-air Pipes carrying the same Volume of Air at Velocities of 100, 150, and 200 feet per minute."

No discussion.

Respectfully submitted,

J. D. HOFFMAN,

Chairman.

CCXX.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON TESTS.

Your Committee on Tests for the Review Meeting of 1910 would report that it has reviewed the Proceedings of the Society since its organization, and finds reported therein records of tests as below. This list does not include certain papers in which references are made to tests not described.

Only brief descriptions of the nature of these tests are given, for with so many of these Review Committee reports to be made this seemed the best method of preventing conflict with the work of other committees, besides saving the time of those in attendance upon the meeting.

Volume	Year	By	Nature of Test.
1.	1895	Prof. R. C. Carpenter	This test discusses different methods of making measurements, explains minutely method of making radiator tests, describes an extensive series of such tests, and gives complete tables of results.
3.	1897	Prof. J. E. Denton	Two fans are selected for this test of a pattern not used in ventilation work. The discussion thereon is interesting more especially as illustrating the rapid strides in recent years in developing the efficiency of ventilating fans.
4.	1898	Prof. R. C. Carpenter	This paper is a most interesting description of the equipment of the plant of the N. Y. State Veterinary Building at Cornell University, with plans and description, as well as a tabulation of results of boiler test, temperature test, and measurement of heat used in warming the building.
5.	1899	Mr. Wm. S. Monroe	Experiments on the ventilating fans of the Chicago Public Library. It gives actual results obtained from fans as installed for ventilation purposes, also shows the relation between the air delivery and the power, between the air delivery and the pressure, and between the power required and the air velocity for these fans operating under different speeds.
		Prof. R. C. Carpenter	Experiments and investigations on centrifugal blowers, the experiments being made with a fan so made that the scroll could be fastened in any desired position, the object being to determine the effect of the casing and the variation of the pressures produced in different parts of the casing, etc. The record is accompanied by curve sheets giving results of the test. This report is followed by a paper on the theory of the centrifugal fan or blower.

Volume	Year	By	Nature of Test.
5.	1899	Prof. J. H. Kinealy	Designed to give information on heating with steam at or below atmospheric pressure.
6.	1900	Prof. R. C. Carpenter	Testing blowing fans. This is supplementary to 1899 test of fans above referred to.
		Prof. R. C. Carpenter	Test on the condensation of steam in a blower system. The investigation was conducted to determine the effect of changes of pressure in steam coils upon the amount of heat given up to the air, the effect of varying the amount of heating surface upon the heat given up to the air, the effect of varying the velocity of air through the coils upon the heat given up by them, the condensation of steam per square foot of heating surface with various pressure of steam, and tests of the blower used under different conditions.
7.	1901	Prof. R. C. Carpenter	A series of tests of radiators with superheated steam. The result of the tests seems to favor the circulation of steam at low temperatures.
9.	1903	Mr. B. H. Carpenter	A test of hot air gravity system of heating and ventilating in a school building.
		Prof. R. C. Carpenter	Test of cast iron heating surface in connection with a fan system of heating. This test is especially interesting in view of later developments in cast iron fan heating coils.
		Mr. John J. Harris	The record of the operation of a plant for cooling an auditorium by the use of ice.
10.	1904	Prof. R. C. Carpenter	A series of tests intended to show the necessity of moisture in heated houses.
11.	1905	Prof. R. C. Carpenter	This paper was offered by Prof. Carpenter as a report of The Committees on Tests, being the first test reported by a Committee on Tests. It describes a test of a steam heating boiler (sectional) carried out very much as is the standard test of a power boiler, in which there was evaporated 10.25 lbs. water from and at 212 degrees per lb. combustible.
13.	1907	Committee on Tests	A series of tests on radiators to determine their relative heating capacity, illustrating in detail the method of making the tests.
			A record of an efficiency test on underground hot water lines installed in wood boxing, the tests being made under the supervision of the Chairman of the Committee.
		Prof. R. C. Carpenter	A paper on the "Derivation of Constants for Building Losses," quoting tests on wall and glass losses which seem to affirm the substantial accuracy of Peclet's experiments.
14.	1908	Prof. John R. Allen	The Transmission of Heat through Radiator Surfaces at Various Temperatures. (See below).
		Mr. H. W. Whitten	In the course ot a topical discussion Mr. Whitten gave figures on the air leakage about windows.
		Mr. T. N. Thomson (For Special Com.)	A description of tests designed to show the Relative Corrosion of Wrought Iron and Soft Steel Pipes.
		Topical Discussion	In the course of this discussion Prof. Kent submitted a paper describing a method of testing house heating boilers. (Printed and submitted at Annual Meeting, 1909).
		Mr. Theodore Weinshank	Describes the methods used and results obtained in testing Cast Iron Heaters for Hot Blast Work, the heaters being of the type known as the Vento Heater. The object of the tests were to show the temperature rise, the velocity of the air, etc.

Volume	Year	By	Nature of Test.
14.	1908	Mr. H. W. Whitten	In a topical discussion the results of further tests on heat and air leakage about windows were given.
		Prof. John R. Allen	This is the paper referred to above as presented in manuscript. It presents in an admirable way the results of a large number of tests of direct radiators, the tests being made with pressures ranging from practically atmospheric pressure to seventy pounds gage. The paper includes a discussion on the temperature to which a room must be heated for various outside temperatures.
15.	1909	Committee on Tests	Record of tests on two cast iron heating boilers by Mr. Roy E. Lynd, accompanied by table of results and formulæ used. Summary of two tests upon a central hot water heating plant, with deductions as to the effect on the cost of heat generated if the exhaust steam were charged to the electric generating plant instead of to the heating plant. Data of test of automatic steam pump used for returning water of condensation of heating plant to boiler.
		Mr. T. N. Thomson (For Special Com.)	A description of further tests to determine the relative corrosion of Wrought Iron and Steel Pipe.
		Mr. H. W. Whitten	Further information and tests on air leakage about windows.
		Prof. John R. Allen	The effect of Painting Radiating Surfaces, a paper showing the effect of different radiator finishes and also the effect of humidity, in which it is shown that the character of the finish effects very materially the efficiency of the radiator.
		Mr. A. M. Feldman	A description of a Ventilating, Heating and Cooling Plant in a Bank Building, giving results of several tests of the plant, including figures as to refrigeration required, air cooling accomplished, effect on humidity, etc.
		Mr. H. W. Whitten	Further Examples and Tests of Wind effects on Ventilation and Heating.

It was at first intended to compile not only a list of the tests of record, but also a list of tests which might be desirable additions to the Society's records, but this latter part of the plan was abandoned because such a list of tests would be a varying one, depending only on who should make the list. The tests on record are few enough so that every member of the Society will be able to think of other tests which would make desirable and valuable additions to the Society's records. A further reason lies in the difficulty of suggesting tests which may not seem to be in the interests of certain manufacturers, a difficulty frequently referred to by the Committee on Tests. It may be that we as a Society are unnecessarily cautious in this manner.

A review of the above list will show five tests on fans (but none since 1900), six on direct radiators, three on fan coils,

four on sectional boilers, four on completed plants, and other interesting tests, but none on other types of boilers, many of which are used in large heating plants, pumps, indirect radiators, pipe coverings, multivane fans, and many other materials and devices with which we are brought into constant contact. It is more than probable that members of the Society have made many such tests in the conduct of their business that would prove valuable additions to the Society's records. The suggestions frequently made by past Committees on Tests, that the members volunteer papers on tests of interest to the profession, is again submitted.

The Society should consider itself especially indebted to Professor Carpenter for the many valuable papers on tests submitted by him.

It will be noted that but few of these tests appear as official tests of the Society's Committee on Tests. The reasons for this have frequently been brought to the attention of the Society, and may be summed up in the oft-mentioned lack of funds at the disposal of the Committee, and the difficulty of preventing the use of the Society in the advertising of manufacturers' wares, as referred to above.

It may not be desirable to precipitate again the argument as to the desirability of discontinuing the Standing Committee on Tests in favor of the plan of appointing special committees on special subjects, but the above record and possible field of work of this Committee will prove a strong argument in favor of the latter plan, especially in view of the admirable results obtained by appointing the special committees. The recent work of this Committee has been more fruitful than formerly, however.

It is encouraging to note the increased interest of the members in tests as demonstrated by the greater number of tests recorded in the later volumes of the Proceedings.

Respectfully submitted,

D. D. KIMBALL.

CCXXI.

REPORT OF COMMITTEE ON RELATIVE CORROSION OF WROUGHT IRON AND STEEL PIPES.

Your committee appointed to continue tests and secure data on the relative corrosion of wrought iron and steel pipes hereby reports progress.

It is endeavoring to accumulate facts obtained by tests made under working conditions. It is not looking for opinions, because it has reason to believe that very few engineers have had an opportunity to give sufficiently close attention to this subject

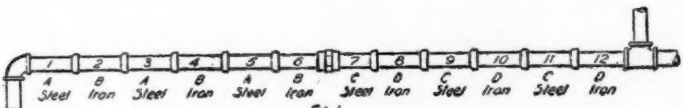

Fig. 1

to correctly identify wrought iron from soft steel pipes while pursuing their regular vocation. This being so, your committee feels that it should make tests itself, or have them done under its own supervision, and it is along this line that we are now endeavoring to collect data.

Up to the present time we can only report definitely on one test as follows:

This test consisted of six pieces of two-inch strictly wrought iron pipes and six pieces of two-inch steel pipes each about $9\frac{7}{16}$ inches long over all measurements including the threads, and joined together with wrought iron couplings in the ordinary manner, as shown in Fig. 1. These samples were secured from different sources which we will, for convenience, represent by the letters A, B, C, and D, and were tested out and identified. They were screwed together and inserted on the same line and under exactly the same conditions as existed in the test which was illustrated and described in the paper by T. N. Thomson at

the 1908 Annual Meeting of this Society. The test we report now was made, in a measure, as a check on the test previously referred to in the said 1908 paper.

We consider it valuable at this time, inasmuch as it shows the behavior of modern wrought iron and steel pipes when subjected to internal corrosion during actual working service, each sample of pipe in the test being subject to exactly the same working conditions and the same corrosive influences as the others.

The samples were inserted in a hot-water circulating line, as shown in Fig. 2, being located near the ceiling of the engine room of the Instruction Building of the International Correspondence Schools in Scranton, Pa. The samples were inserted

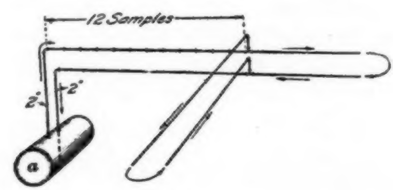

Fig. 2

November 18, 1907, and were used as part of a hot-water circulating and distributing system that conveys hot water from a boiler *a* to 24 combination faucets at press-room sinks continuously till November 30, 1908, when they were removed because of a leaky seam which developed in the sample marked No. 8. The water was heated by a brass steam coil in *a,* and flowed through the samples with a velocity that was never high enough to remove the rust as it formed inside the pipes. The temperature of the water was approximately 200 degrees F., and the pressure varied from about 80 pounds to 130 pounds per square inch.

The accompanying table shows the effect of the corrosion on the different samples.

It will be observed that the steel pipe obtained from A is very much superior to the steel pipe obtained from C. The metal under the deepest pitting in the A samples is .0700 of an inch thick, while the metal under the deepest pitting in the C samples

CORROSION TEST NO 2.

MADE IN A HOT-WATER PIPE LINE IN THE INTERNATIONAL TEXTBOOK COMPANY NEW PRINTERY.

Pipes put in service, November 18, 1907. Pipes removed, November 30, 1908.

BOILER END.	1 Steel. *A.*		2 Iron. *B.*		3 Steel. *A.*		4 Iron. *B.*		5 Steel. *A.*		6 Iron. *B.*		7 Steel. *C.*		8 Iron. *D.*		9 Steel. *C.*		10 Iron. *D.*		11 Steel. *C.*		12 Iron. *D.*	
Length in inches end to end of thread	9 7/16		9 7/16		9 7/16		9 7/16		9 7/16		9 7/16		9 7/16		9 7/16		9⅝		9 7/16		9 11/16		9 7/16	
Weight in ounces when first put in without couplings	38½		41		38½		41		38¾		41		40⅝		39⅝		41⅜		41⅜		41¾		41	
Weight without couplings in ounces when pipes are taken out and rust removed	31⅝		35¼		32½		34¾		32¼		34⅜		35⅜		32¾		34½		35⅛		35¼		32	
Weight in ounces lost by corrosion	6⅞		5¾		6		6¼		6½		6⅝		5¼		6⅞		6⅞		6¼		6½		9	
Per cent. of weight lost by corrosion	17.9−		14+		15.6−		15.2+		16.8−		16.2−		13+		17.4−		16.6+		15.1+		15.6−		22−	
	1 *T.*	1 *B.*	2 *T.*	2 *B.*	3 *T.*	3 *B.*	4 *T.*	4 *B.*	5 *T.*	5 *B.*	6 *T.*	6 *B.*	7 *T.*	7 *B.*	8 *S.*	8 *S.*	9 *T.*	9 *B.*	10 *T.*	10 *B.*	11 *T.*	11 *B.*	12 *T.*	12 *B.*
Thickness of material under deepest pits	.1264	.072	.0750	.0862	.0833	.0906	.0937	.0820	.0935	.0983	.1117	.1225	.0490	.0851	.0683	.1000	.0752	.0540	.0872	.0462	.0814	.0472	.0910	.0632
	.0984	.0816	.0842	.0966	.0875	.0901	.1030	.0992	.0935	.0857	.1057	.1150	.0633	.0840	.0827	.0839	.0670	.0638	.0854	.0620	.0516	.0659	.0800	.0460
	.0965	.0830	.0830	.0900	.0874	.0940	.0890	.1070	.0935	.0757	.0983	.1055	.0590	.0722	.0598	.0930	.0520	.0620	.1057	.0823	.0406	.0387	.0868	.0578
	.0943	.0830	.0957	.0833	.0850	.0887	.0812	.1015	.1000	.0970	.1164	.1047	.0767	.0766	.1078	.1064	.0840	.0647	.1005	.0820	.0547	.0480	.0810	.0480
	.0890	.0700	.0930	.1042	.0953	.0841	.0809	.0870	.0944	.0825	.1017	.1160	.0534	.0850	.0789	.0999	.0890	.0695	.1132	.0883	.0608	.0720	.0516	.0720
Least thickness	.....	.0700	.0750	.....	.0833	.....	.0809	.....	.....	.0825	.0983	.....	.0490	.....	.0598	.....	.0520	.....	.....	.0463	.....	.0387	.....	.0460

is .0387 of an inch thick. This means that C's pipe will corrode through much more rapidly than A's pipe. The table shows that the weight of each of A's samples was 38½ oz., while C's samples each weighed about 40⅜ oz. for the same length. This means that C's pipe had originally an average thickness greater than that of A's pipe, yet the thicker pipe is considerably less durable than the thinner pipe, as can easily be seen from the samples which are open here for your inspection.

In a similar manner it can be seen that the samples obtained from B are much more durable than the samples obtained from

Fig. 3

D, even although the original weights and thicknesses were practically the same in both.

It will be seen that the least durable piece of pipe in the test is C's No. 11, which has .0387 inch of thickness under its deepest pitting, while the second and third poorest pieces are D's pipe with a difference of .008 of an inch in favor of the latter.

The samples obtained from C and D can hardly be called first-class pipe when compared with the samples of A and B.

Assuming the samples from A and B to be good quality steel and iron pipe, respectively, we will now consider their relative lives. To accurately obtain this we must find the depth of the deepest pitting and compare it with the original thickness of the pipe. Thus:

A's poorest steel sample is No. 1, and the deepest pitting is in the bottom half. B's poorest wrought iron sample is No. 2, and the deepest pitting is in the top half. Fig. 3 shows the depths of the pittings at these points.

The standard thickness of 2-inch full-weight pipe is .154 of an inch, but as the steel samples were 38½ oz. as against 41 oz. for the iron, the original thickness of the steel was practically

$$\frac{.154 \times 38.5}{41} = .1446 \text{ inch.}$$

The exact depth of the pitting in the wrought iron, therefore, is .154 — .0750 = .0790 inch, while the depth of the steel is .1446 — .0700 = .0746, showing that the actual depth of the deepest pitting in the poorest piece of A's steel pipe is not as bad as the actual depth of the deepest pit in the poorest piece of B's strictly wrought iron, the difference being .0790 — .0746 = .0044 of an inch in favor of the steel pipe. If we consider the

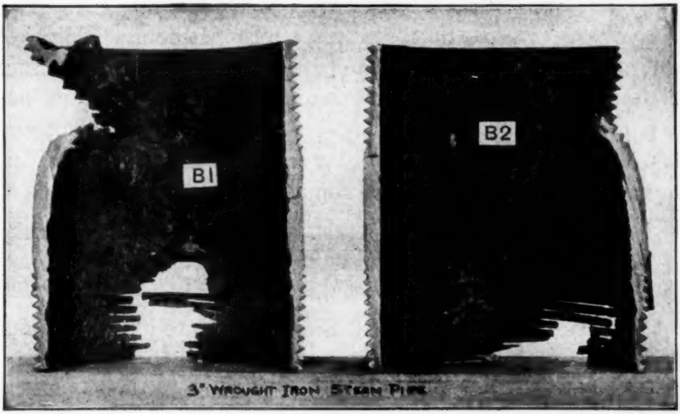

FIG. 4.

fact that steel is about 2 per cent. heavier than wrought iron, the difference will be in favor of the steel.

If A's steel samples had been originally as thick as B's iron samples, the metal under the deepest pitting would have been about .0700 + .0094 = .0794 as against .0750 for the iron.

This test checks up well with the aforesaid 1908 paper, and we believe demonstrates that modern steel pipe of good quality is, at least, as durable as modern strictly wrought iron pipe of good quality, and is very much superior to a poor quality of wrought iron in this class of work.

This test suggests that the durability of a pipe depends more upon the quality of the metal than upon its thickness.

In closing we desire to call special attention to the fact that we find it is not safe to accept reports regarding the corrosion of wrought iron and steel pipes without first identifying the ma-

terials, because so many engineers cannot ordinarily distinguish the difference between them.

We can quote a few instances to prove this statement, but the following we think is sufficient:

At our last annual meeting one of our members brought two 3-inch short nipples and presented them as examples of quick corrosion in steel pipe. They were believed to be steel nipples by some of the members, while others thought they were wrought iron, but nobody had a definite opinion. We were then requested to have them taken away and tested, which was done. We sawed each of the nipples in halves and had a photograph taken of each of the defective halves. They are shown in Fig. 4. We had these nipples tested in three ways by three entirely different people. A test by analysis made by an experienced metallurgical engineer showed the following composition:

	Sulphur.	Phosphorus.	Manganese.	Carbon.
B 1	.022	.229	trace	trace
B 2	.026	.251	trace	trace

The analyst's decision is that there is no question of this material being wrought iron.

A fracture test being applied showed without a doubt that the nipples are wrought iron, as you can see by the broken pieces we lay before you for inspection.

The acid test was applied by an experienced structural engineer in accordance with the instructions published by pipe manufacturers, and his decision is that the nipples are both wrought iron.

So here we have a specific case where an expert heating engineer presented to our body two wrought-iron samples under the impression that they were steel, and nobody present could prove him wrong.

This example is enough to teach us to be cautious in coming to conclusions regarding the relative corrosion of wrought iron and steel pipes.

Respectfully submitted,

THOS. N. THOMSON, *Chairman*,
THOS. BARWICK,
F. N. SPELLER,
Committee.

CCXXII.

REPORT OF THE REVIEW COMMITTEE FOR 1910 ON COMPULSORY LEGISLATION.

The American Society of Heating and Ventilating Engineers. has, through a Special Committee on Compulsory Legislation, endeavored during the past fifteen years to bring before the members of the various State Legislatures the necessity of ventilating public buildings. In January, 1909, a Review Committee was appointed to report what progress had been made in this line, and the following is a report made by John F. Hale, Chairman, at the annual meeting of the Society held in New York, January, 1910:

The investigation made by the Committee on Standards of this Society was reported upon at the second annual meeting held in New York, January, 1896. This Committee made extensive research and inquiry from experts the world over, and to those who are not familiar with the early proceedings of this Society it will be of interest to read its report in the early pages of Vol. 2, 1896.

The Committee found that there was great difference of opinion as to the number of cubic feet of air to be provided per person per hour, this ranging from 1,000 cubic feet to 2,100 cubic feet, according to the age of the occupants of the room, where the building to be ventilated was located, as well as the personal opinion of the individual as to what should be considered the limit of impurity of the air as indicated by the number of parts of carbon dioxide in 10,000 parts of air. The recommendations made by the Committee on Standards were as follows:

First: That for all buildings such as schools and asylums occupied almost entirely by children and youths under fifteen years of age, the minimum amount of air for ventilation should be 1,800 cubic feet per hour per person.

Second: That for all buildings occupied by persons over fifteen

years of age, the minimum amount of air for ventilation should be 2,000 cubic feet per hour per person.

Third: That for buildings lighted in part or wholly by gas, the minimum amount of air supplied for each gas light should be 3,000 cubic feet per hour.

At this point in the proceedings of our Society begins the real work of the Committee on Compulsory Legislation.

In the beginning the question arose as to the definition of a "Public Building," for the committee's work was to look after legislation in the various States in the Union and to see that laws were enacted making it necessary to ventilate buildings so designated; but your Committee has been unable to find anything in the proceedings of the Society that sets forth what constitutes a public building, as school houses seem to be the only class of buildings that have been specifically named. It has been suggested that the bills presented in future shall state clearly what buildings or classes of buildings are referred to, as they may include municipal buildings, court houses, jails, city and county hospitals, asylums, reformatories, houses of refuge, as well as state prisons, hospitals, asylums, institutions of learning, including normal schools and colleges, as well as public and high schools.

It is also well to call attention to the many private institutions, schools, hospitals, theaters, auditoriums and places of amusement and learning, none of which seem to come directly under the regulations but should be ventilated under the law.

Laws regulating the ventilation of school-house buildings are in effect in Massachusetts, New York, New Jersey, Pennsylvania, Virginia and Utah, and bills have been prepared and will come up in 1911 for serious consideration in Illinois, Indiana, Wisconsin, California, Colorado, Maryland, Michigan, North Dakota and West Virginia.

In Connecticut, Indiana, Minnesota and Vermont rulings have been promulgated by the State Board of Health in an attempt to regulate the ventilation of schools, but there is no law providing for a fine for non-enforcement of the provision.

Your Committee has written letters to State Representatives, Secretaries of State, Boards of Health, Members of the State Legislatures and Members of this Society in every State

in the Union during the last year, and has been compelled to write many times to some before getting any reply, and it is well to state here that less interest was shown by members of this Society in making prompt and satisfactory replies than in the case of public officers.

In Alabama no ventilation law is in effect, and the Secretary of State says there are no bills pending. Legislature meets again in 1911. We are also informed that the same conditions exist in Arizona and Arkansas.

A bill based on the Massachusetts law has been drafted and will be presented at the next California Legislature meeting in 1911. Thomas Morrin, a member of this Society and located at San Francisco, has this matter in hand.

In 1906, House Bill 392 was introduced by one Mr. Smith, in the Colorado State Legislature and pushed by F. C. Goff, Chief Engineer of the Board of Education of the City of Denver, assisted by Howard H. Fielding, both members of this Society, but was never made a law, although the originators of the bill hope for success in 1911.

There is no law now in effect in the State of Connecticut relating to the ventilation of public buildings, except that in the Revision of the General Statute 1902, paragraph 2505 under the caption of "Duties of the State Board," will be found the following: "Said Board shall take cognizance of the interests of health and life among the people of this State; shall make sanitary investigations and inquire respecting the causes of disease. Shall cause to be made by the Secretary, or by a Committee of the Board of Inspections, at such times as it may deem best and wherever directed by the Governor or the General Assembly, of all public hospitals, prisons, asylums or other public institutions in regard to the location, drainage, water supply, disposal of excreta, heating and ventilation and other circumstances in any way affecting the health of the inmates."

This, it will be noted, is little better than no law at all, for there is no specific statement as to what constitutes ventilation, as under this ruling the opening of a door or window would be sufficient to satisfy the inspector.

The Secretaries of State in both Delaware and Florida inform the Committee that no law is in effect and so far as they know no bills have been presented for consideration.

The State School Commission in Georgia informs your Committee that although no law is in effect, most of the present installations in schools, theaters and public places have been equipped with blast fan apparatus for ventilating purposes.

Idaho has no law calling for the ventilation of public buildings, so we are informed by the Secretary of State.

In Illinois the subject has been under consideration for some years, having first been suggested by Thomas J. Waters, at that time Chief Engineer of the Chicago Board of Education (see page 24, vol. 12, proceedings of this Society), but it was not until 1907 that the matter was taken up definitely, at which time the Illinois Chapter appointed a committee to prepare a bill and have it introduced if possible. Unfortunately this was brought before the legislature so late in the session that it was never acted upon.

In 1909 the senatorial fight in the State of Illinois prevented the local committee from doing anything at that time, so that it is again a future prospect for 1911.

The bill above referred to is known as House Bill 851, 1907, introduced by Mr. Church, April 17, 1909. A copy of this bill is in the possession of the Committee, but is not included in this report.

On January 1, 1910, a law went into effect in the State of Illinois, this relating to "the health, safety, and comfort of employees in factories." This law provides for a given quantity of fresh air for rooms containing various cubical contents; a full text of those sections relating to ventilation will be found in another part of this report.

As stated in this year's report of the Committee on Compulsory Legislation, the attempt was made in 1909 to have a law enacted in the Indiana State Legislature, and, in fact, it had reached the third reading in the house when it was killed, not because of any objection to the bill, but because the man who had introduced it had done something to displease certain legislators in power. The bill was known as Senate Bill 15, 1909, and a copy of same is in the possession of this Committee available for future use.

The State Board of Health, under the leadership of Dr.

Hurty, has done much to improve conditions in the Indiana State Schools, and those who heard him speak at the Indianapolis meeting have no doubt as to the great importance of the movement to get more perfect air in our school-rooms. The State Board of Health has power to dictate the results to be had in schools, but unfortunately there is no law upon which to base its demand. The bill which was defeated last year will be introduced again in 1911.

Inquiries from the Secretaries of State of Iowa, Kansas, Kentucky, Louisiana and Maine bring the same reply, to the effect that no law has ever been enacted, nor are there any bills in preparation or up for consideration.

Your Committee is informed by Mr. Henry Adams, a member of this Society from Maryland, that attempts have been made to have a law enacted in that State, but without success to date. A bill will be presented at the next Legislature however.

The Massachusetts law, which went into effect in 1894, preceded the organization of the American Society of Heating and Ventilating Engineers, was revised in 1901 and may be found in Chapter 104 of the revised laws of the State of Massachusetts, also under inspection of buildings, Sections 22, 23 and 24, Chapter 106, Sanitary Provisions 54 and 55. See also codification of the labor laws as enforced by district police, Chapter 514, acts of 1909, Sections 83, 105 and 106. Copies of the above, together with report blanks used by the inspectors of the department, form a part of this report.

Several attempts have been made to have a law enacted in the State of Michigan, but without success. A bill has recently been prepared by the Michigan member of the Committee on Compulsory Legislation, and he has to report that it will be presented at the next meeting of the Legislature in 1911. This bill calls for heating, lighting, sanitation and ventilation of certain specified quality for any public building, school, church, theater, auditorium and assembly hall, the cost of which exceeds $4,000. The requirements are similar to other laws on the subject, including 70 degrees Fahrenheit temperature in zero weather, 15 square feet of floor space and 200 cubic feet of air per occupant and 30 cubic feet of fresh air

per hour per occupant. The full text of this bill is in the possession of the Committee.

Mr. F. R. Still, of Detroit, who has much to do with the bill, recommends that the next Committee on Compulsory Legislation keep the matter before them and see that the bill is brought before the house early enough, so that it will receive the consideration it deserves.

Although there is no actual ventilation law in the State of Minnesota, the State Board of Health has revised "regulations relating to the construction of school buildings," and in No. 14, which covers the principal features of the laws in other States specifies 18 square feet of floor space and 216 cubic feet of air space with 30 cubic feet of fresh air per hour per person, etc., etc.

In Mississippi there is no law or bill in prospect, and although the matter has been up for consideration in Missouri, your Committee was unable to get a copy of the bill prepared, nor could it be learned what was in prospect.

In Montana, Nevada and New Hampshire there are no ventilation laws, while in Nebraska the ventilation feature was not made a part of the so-called "ventilation" law recently enacted in that State.

In 1903 a school law was enacted in the State of New Jersey and is known as the "Stokes" law, having been introduced by Governor Stokes at the time he was a member of the Legislature. The Committee from this Society was instrumental in having the original bill introduced. For a copy of this law see page 23, vol. 12, 1906, which also forms a part of this report.

In New Mexico, Oklahoma and North Carolina there is no ventilation law, nor is one in prospect, but your Committee is pleased to report that a member of the North Dakota State Legislature has promised to try and have a bill passed next year and a bill is in preparation based upon other State Laws relating to the subject.

After much labor and personal sacrifice the New York members of this Society succeeded in having a law enacted in their State in 1904, the full text of which, together with the

Committee's report will be found on pages 14 to 19 inclusive, of vol. 9, 1903. A copy forms part of this report.

In the State of Ohio there is no ventilation law, but certain regulations are set forth by the Department of Inspection of work-shops, factories and public buildings, in which it will be found that 65 degrees Fahrenheit in zero weather is the temperature required in schools, and that either a direct or a furnace system is to be used for heating, although this is not carried out in actual installation, as a combination of direct and blast is more frequently used in the larger cities of Ohio. The ventilation requirements in the code are very incomplete, specifying 200 cubic feet of space for each pupil, but making no mention of the supplying of any given quantity of fresh air. It does seem that some attempt should be made to have a ventilation law enacted in this State.

Inquiry from members of this Society and several State officials brings out the facts that no ventilation laws exist in Oregon, Rhode Island, South Dakota, South Carolina, Tennessee, Texas, Washington or Wyoming.

On page 22, vol. 12, 1906, will be found a copy of the law signed on April 22, 1905, by Governor Pennypacker of Pennsylvania, this being the direct result of the work of a Committee appointed by this Society. A copy of said law forms a part of this report.

A law was enacted by the Utah State Legislature at the last session calling for 15 square feet of floor space, 200 cubic feet of air per pupil and fresh air to the extent of 30 cubic feet per hour per pupil. A copy of the law relating to this subject forms a part of this report.

As stated in the report of the Committee on Compulsory Legislation, regulations have been promulgated in the State of Vermont relating to this subject and future Committees are referred to that report.

On March 11, 1908, the Virginia State Legislature enacted a law which is for the purpose of regulating the construction of public buildings, in order that the health, sight and comfort of all pupils may be properly protected. In this, the State Board of Inspectors for public buildings are given power to pass upon the plans for the erection of any school building

or room in addition thereto. See Virginia Laws Revised Acts 1908, page 266, copy of which is included hereinafter.

Your Committee is informed by Mr. O. L. Badger, member of this Society, that in 1899 or 1900 he assisted in the drawing up of a bill which a Mr. George of Brook County, West Virginia, introduced to that Legislature, but unfortunately the bill died in the Committee room.

It would seem to the writer that this bill should be revived, and as Mr. Badger offers to follow the matter up, why not refer the matter to him under the control of the Committee on Compulsory Legislation for 1910?

At the last session of the Wisconsin State Legislature Senator Burke introduced Senate Bill 139-S-1909, relating to "ventilation, heating, sanitation and protection from fire in public buildings," but the Senate Committee having the matter in charge failed to present the bill and as a result it will have to be introduced again next year.

From the above it will be seen that of the forty-nine States and Territories in the Union but six, or 12⅓ per cent., have ventilation laws; but two, or 4 per cent., have State board of health regulations; three, or 6 per cent., have bills pending, and but eight, or 16⅓ per cent., have bills being worked upon, this leaving 61⅓ per cent. of the States in the Union with no laws or prospects.

The writer would recommend that the Committee on Compulsory Legislation for 1910 be requested to do the preliminary work in introducing bills and getting State Legislatures interested, as the final work will be thrust upon the 1911 Committee, most of the Legislatures meeting in January of that year, and although neither Committee could accomplish much alone, by proper coöperation, conscientious work and real endeavor many of the States could be brought into line.

A copy of the report submitted at this meeting by the Committee on Compulsory Legislation for 1909 should be considered a part of this report in order to make it complete.

John F. Hale,
Chairman Review Committee.

January 15, 1910.

CCXXIII.

REPORT OF REVIEW COMMITTEE ON ELECTRIC HEATING.

Probable Future, 1895—*Topic.*

Mr. Jellett: In Philadelphia a number of trolley cars on suburban lines are heated satisfactorily by electricity. The cost, however, is admitted to be excessive. This question suggests itself to us, Will it be possible to run a wire into a building and by this means furnish the necessary light, heat and power for that building; and if so, will there then be any use for steam in that building?

Mr. Hart: Judging from present methods, the heating engineer will have practically no competition in electric heating, as the cost of current is commercially prohibitive.

1 electrical H. P. = 12 ordinary 16 C. P. incandescent lights, and gives off heat equal to 2 common gas jets. Ninety-nine per cent. of the energy is heat and 1 per cent. light; this shows how much energy is expended in obtaining heat.

Car heaters connected in series, 6 to a car, require a total of 8 ampères, and with 500 volts there are required 4,000 watts, or nearly 5½ H. P. of energy for heating alone, while 15 H. P. is required to run the car with its average load.

All present methods of heating electrically are by the "resistance system," consisting usually of coils of wire through which the current passes and from which heat is given off.

According to a well-informed writer the consumption of coal is a little more than 28 per cent. of that required to do the same amount of heating electrically.

Quoting from letter of Mr. W. S. Hadaway, electrical expert: "In room heating on a large scale a close figure for use is that 1 electrical H. P. will heat (by resistance solely) 7.5 sq. ft. of common radiating surface to 1.35° F. above the room temperature.

It is in combination with present low temperature methods of heat distribution that I look for the greater uses of electricity in heating. Fifty per cent. of the fuel energy can be utilized in steam heating, while only about five per cent. can be utilized in high temperature heating. I think you may look for more competition from gas heating than from electric heating."

Mr. Baldwin: An 80 H. P. engine and dynamo developing about 50 H. P. passing 280 ampères at 110 volts through a resistance coil the size of a nail keg appeared to give off less heat than a 40 sq. ft. radiator.

ELECTRIC HEATING—*Paper*—by W. S. Hadaway, Jr. (member) 1896.

The subject considered here is the practical adaptability of commercial electricity for heating purposes and for performing useful work under the conditions imposed in general industrial and domestic life.

In room-heating apparatus on continuous run we may figure that 1 watt, 3.4 thermal units per hour, will heat 1 sq. ft. of common radiator surface through 1.35 deg. F. above the room temperature, which means that 100 watts is practically equal in heating effect to 1 sq. ft. of ordinary low pressure steam direct radiation.

We may assume the average price of the H. P. hour from large steam electric stations to be 5 cents. As a comparison, for 40 cents a consumer may get 1,110,000 B. T. U. of steam heat, or 20,518 B. T. U. from the electric station, a ratio of practically 50 to 1 in favor of steam heat. Clearly the steam electric light station ranks low as a heat distributor for house warming on a large scale.

When electricity is derived from water power we may expect a far wider availability of energy from heat of resistance for house warming than when electricity is derived from steam power.

Careful deductions show that the cost of the H. P. year must not exceed $6.00 in order to compete directly with good coal at $5.00 per ton for house warming in this latitude. We would secure as much heat by applying a brake directly to the flywheel of the engine or prime mover as we obtain from the heat of elec-

trical resistance which, as far as its results go, may be considered as friction.

At the rate of $2.00 per H. P. per month, it costs about $10.00 per month to heat a 20-ft. car. One hundred and fifty-five cars, each 38 ft. 8½ in. long x 7 ft. 10 in. wide x 8 ft. 6⅞ in. center height and 6 ft. 7¾ in. side height, and 208 sq. ft. glass surface per car, use a minimum of about 7,000 watts each car.

To heat a bath room 20 minutes each day with a 1 H. P. electric heater at 10 cents per H. P. hour will cost practically $1.00 per month. In cooking by electricity it costs about 2.5 cents per person per meal.

Respectfully submitted,

T. N. THOMSON,

Chairman.

CCXXIV.

REVIEW REPORT ON STEAM HEATING FOR LARGE BUILDINGS.

Upon notification of the Secretary, that the President had appointed the writer as chairman of this committee, I was in doubt as to where to begin, as the size of a building is purely relative, but when at a later date advice came from the Secretary that school buildings should be included in the paper I found the first portion of the problem had been solved for me.

Upon going through the Society's records it will be found that schools and churches have been a favorite topic, there being five of the former and six of the latter of a total of eighteen papers in the large building class; hotels, hospitals and prisons being used once, while libraries and office buildings were twice the subject of papers and discussion.

In Vol. 1, page 75, will be found the first paper read before this Society. It relates to the heating and ventilating of school buildings, and was written by Thomas J. Waters of Chicago, a man who did much of the pioneer work in the West toward bringing the heating and ventilating of schools to its present state, but who since the last annual meeting of this Society has passed out of this life.

The paper referred to describes the method of school heating in the days immediately following the use of hot-air furnaces in large schools of this type, which included 4 pipe coils in the basement, inclosed in brickwork, from which chamber thus formed the tin ducts led to the rooms and halls above.

Then follows the description of the evolution of heating apparatus from that just mentioned to the introduction of the combined direct and indirect system, where wall coils were provided for all classrooms and corridors, and staggered pipe radiators were placed at the base of the fresh-air ducts.

The introduction of the fan blowing air over pipe radiators,

and the addition of a tempering coil in the cold-air inlet, were followed by the experiment of adding an exhaust fan to the equipment, which was subsequently abandoned, owing to its tendency to cause drafts. In Mr. Waters' paper he tells how he demonstrated the correctness of the quantity of air required per pupil, viz.: 30 cu. ft. per minute, in the following words:

"The above fact was clearly demonstrated a few years ago in a classroom which had a seating capacity of sixty pupils; owing to the crowded condition of the building, however, ten additional pupils were placed in the room, and after school was in session about one hour it was found necessary to open some of the windows, owing to the vitiated condition of the air. A short time after an additional room was fitted up to relieve the crowded one, and as soon as the extra pupils were removed from the room referred to there was no further difficulty experienced."

The discussion of this paper was spirited and brought out many good suggestions, one being a warning against the placing of vent ducts in outside walls; another recommending that all vent flues where not connected with an exhaust fan should run through the roof and not terminate in the attic, as the latter construction frequently resulted in counter-currents, forcing vitiated air back into the rooms, owing to peculiar local conditions which might exist.

The description of a prison heating and ventilating plant by H. B. Prather, Vol 1, page 160, 1895, describes and illustrates a blast system of heating and ventilation using no direct radiation whatever, and although the paper was very complete it contained no striking features that need be mentioned here.

In Mr. H. B. Prather's paper, Vol. 2, page 92, it was brought out very forcibly that frequently in the selection of a heating apparatus for a church, the committee looked more upon the elaborate catalogue of the bidder and the cheap price than upon the actual merit of the system offered, and stated that in church heating the engineer should exercise special care and liberality in the design of such plants. The apparatus described in the paper was most complete and the ventilating system quite elaborate.

In the discussion there were many adverse statements made against Mr. Prather's design, but the general opinion seemed to

be in favor of high grade and complete systems for heating church buildings. Attention is here called to a suggestion made on the floor at the time to the effect that it would be well for some papers to be read in future meetings describing systems that had proved failures, containing lessons by which all might profit.

In Mr. George W. Kramer's paper, read at the same meeting in 1897, he described a hot-air blast system using fans for delivering the fresh air over and around the heater or furnace in a large church edifice in Akron, Ohio.

The furnaces used were especially designed for the purpose and were provided with extended surface, so that the heat extracted would be at the maximum. Mr. Kramer said the apparatus described had been in successful operation for several seasons, still little use has been made of this method of heating until very recently.

The members will do well to read the paper and the description which followed as it contained a method of heating buildings of this type that has almost been overlooked.

On page 155 of Vol. 3, 1897, will be found a very complete description of a steam heating apparatus entitled, "Circulation of Steam for Heating Purposes at or Below Atmospheric Pressure," by Reginald P. Bolton, and although it does not relate particularly to the heating of large buildings, I cannot refrain from its mention here, as the subject is a very important one to the heating and ventilating engineer.

What Mr. Bolton said in his paper about the particular system described is more than true of several of the more modern and up-to-date vacuum systems on the market to-day. Mr. Bolton's paper related to a system using a thermostatic member to operate the return valve which has long since been supplanted by the valve operated by flotation or differential pressure.

The test made by Professor R. C. Carpenter and described in his paper, Vol. 4, page 114, entitled "A Test of the Heating and Ventilating Plant, New York State Veterinary ,College, Cornell University, Ithaca, New York," was most complete, and is a valuable chapter in the literature of heating and ventilating, including as it did an illustration of the entire system in detail, radiators, piping, registers, fans, heater coils, damper regulators,

temperature control, etc., etc., a digest of which, including the discussion, should enable one to design, install and operate a plant of this sort without reference to any other authority.

English practice in the warming and ventilation of technical or art schools, page 208, Vol. 4, was a very interesting paper read at the 1898 meeting by D. M. Nesbit, of London, England, and was a most complete description of the method employed in England for heating buildings of the school type.

The system was a mechanical one, using a fan under plenum conditions, supplemented by exhaust fans to assist in the removal of foul or vitiated air. But attention is particularly called to the system of washing incoming air in a crude but nevertheless effective manner. This was long before the air washer of to-day had been brought out in this country.

It will also be noted by reference to the paper that no tempering coils were used, but that all heating surface was placed at some distance from the fan and at the mouth or entrance to auxiliary tunnels leading to the main tunnel, a method the writer has never seen used in this country or described in our literature before or since.

The paper read by Mr. B. H. Carpenter in 1898 and recorded on page 231, Vol. 4, entitled "Heating and Ventilating Church and Parish Buildings by Forced Draft," was a description of a system using fan heating only, without any direct radiation whatever, the foul air being drawn through floor registers by an eduction fan while fresh warm air was admitted into the auditorium by registers at the end of each pew discharging horizontally into the aisles.

Those who discussed this paper dwelt particularly upon the advisability or necessity of using two fans for the ventilation of such buildings, but although it was conceded that in the particular building described the two-fan system was necessary on account of the building construction, it was evident that the building could have been equipped with a successful system using but one fan, although probably not at the same cost.

"Some points regarding the ventilation and heating of tall buildings," by Henry C. Meyer, Jr., Vol. 5, page 92, related to the installation of a fan system of hot-air circulation for tall buildings such as are usually heated by direct steam radiators,

and the writer of the paper cited several instances where this method had been used successfully. The description, however, brought out the statements that the particular plants mentioned were not wholly successful.

The writer knows of but one system of this type in Chicago, and it has been reported to be a failure.

"The Warming and Ventilating of Schools in England," by D. M. Nesbit, of London, England, Vol. 5, page 265, was accompanied by drawings showing the system in detail, and was very similar to the system described in Mr. Nesbit's former paper, in which fresh air was discharged through a main tunnel underground, the heating surface being placed at the entrance to the auxiliary tunnels from which the vertical ducts were fed, the steam piping passing through the main tunnel, thereby preventing heat loss. Two tunnels were shown, both designed on the same lines, neither of which called for any direct radiation whatever.

The paper read by Thomas Barwick at the meeting of 1900, page 39, Vol. 6, regarding the neglect of ventilation in some hospitals, brought forth a very interesting discussion, all of which related to the tendency in buildings of this type to handle the apparatus according to the individual idea of those in charge instead of following instructions. This condition is overcome to some extent in several of our States by the regulations of the State Board of Health, whose inspectors make it their business to see that the laws are understood and carried out.

On page 151, Vol. 7, 1901, will be found a very interesting discussion in reference to the ventilating of office buildings, in which it was shown that ventilation was highly desirable, but offered many difficulties in its application. The space necessary for heat or air-vent ducts and the possibility of changes in partitions to suit tenants, were mentioned particularly, but at best it was but the airing of so many opinions and no conclusions are to be drawn.

In the last ten years attempts have been made to improve atmospheric conditions in office buildings and a paper on the subject for a subsequent meeting would be a profitable one.

"The Heating and Ventilation of the Ed. Wyman School, St. Louis, Mo.," was the subject of a paper by Alvin D. Reed, page

217, Vol. 7, 1901, this being a description of a hot-blast plenum system using no direct radiation, the paper containing no unique or unusual features, although it is the writer's belief that systems of this type are at the present day considered incomplete without direct surface to supplement the fan and for use in maintaining heat in the buildings at night or at such time as the fan may not be in operation.

"The temporary warming of the large hall of the Royal and Imperial Palace Library in Vienna," by Professor Edw. Meter, Vol. 9, page 74, was most interesting and instructive, although the condition described may never arise again. It is a valuable addition to our literature.

On page 83, of Vol. 9, we find a paper read by Mr. W. H. Switzer, entitled "Furnace Heating and Ventilating System in the Public Library in Ilion, N. Y.," and as Mr. Campbell stated in the discussion, there is no doubt that Mr. Switzer had started something in reference to hot-air heating, a subject to which very little study seems to have been given, but about which much can be learned.

Mr. B. H. Carpenter's paper, which followed the one above referred to, was the result of a test of a hot-air gravity system of heating and ventilation in a school building, but inasmuch as it was not intended to be a descriptive paper, but only the report of a test, the discussion was only general and the President suggested that Mr. Carpenter be asked to revise this paper so that the many questions asked might be incorporated in the paper itself, this to be read at a later date.

"The Heating and Ventilation of the Main Auditorium of the Broadway Tabernacle, New York," read by Mr. C. Teran, Vol. 12, page 48, was a description of a hot-blast steam job using exhaust fans to assist in circulation. The discussion which followed the reading of the paper brought out many points of detail which were not covered in the paper itself. It will be profitable reading to those who are interested in this subject.

Samuel R. Lewis' paper read at the summer meeting in 1907, Vol. 13, page 187, was a description of a combined direct and blast system in a group of brick school buildings, and from the discussion it is evident that the subject interested many of the members present. Mr. Lewis described a system designed by

himself read before one of the Illinois Chapter meetings, in which he exhibited plans of a building heated by a combined system using indirect radiators at the base of each hot-air flue, the air first being drawn over tempering coils, and I would suggest that Mr. Lewis be requested to prepare a paper on the subject for one of the Society's future meetings.

Professor J. D. Hoffman's paper read at the Milwaukee meeting July, 1907, Vol. 13, page 205, was a most scholarly and valuable addition to our literature, as it relates to the heating by warm air and gives formulas for the proper computation of sizes, capacities, etc.

On page 58, Vol. 12, 1906, will be found the paper by William G. Snow, entitled "Some Features of the Heating and Ventilating System of the Bellevue-Stratford Hotel, Philadelphia, Pa.," and a careful reading of this paper will be found of much interest and profit to those having a large and perfectly equipped hotel or other large building to heat.

The unique features of this system should be of interest to the student, as, for instance, the placing of the fresh-air intake fans on the roof and forcing the warm air downward instead of allowing it to rise from below as is usual. It is also interesting to know that the bulk of the radiation for heating the corridor on the main floor is placed above the revolving doors, thus fully meeting the problem difficult to solve in the fact that there was not floor space available for the proper placing of direct radiators.

From the foregoing it will be seen that very little has really been written about the heating of large buildings, for, with the exception of Mr. Snow's paper about the Bellevue-Stratford Hotel, none of the modern skyscrapers have been mentioned, and here it would be well to suggest that papers be prepared for future meetings on the heating of one of the large buildings of New York, Chicago or Philadelphia, in which all features relating to the heating apparatus should be covered.

I do not mean the description of the boiler and engine plant which frequently takes up the bulk of a paper, but points relating strictly to the heating, in which the overhead or attic main with the down-feed pipes can be the subject of one paper, and a basement main with up-feed pipes the subject of another.

Both are in common use, and the designers of each have their particular theories as to why their type should be used. I am sure a paper describing the obstacles overcome in such buildings as the Singer or the Metropolitan Life Buildings in New York, would be interesting and instructive, as there are many obstacles to overcome that are not usually met with in the ordinary so-called large buildings.

Why it is that no one has ever made one of the large manufacturing plants, mills or factories the subject of a paper I do not understand, for there is room for half a dozen papers of this kind that would be valuable additions to our literature.

Respectfully submitted,

JOHN F. HALE, Chairman.

Chicago, January 15, 1910.

CCXXV.

REVIEW REPORT ON RADIATORS.

A brief survey of the volumes of proceedings to date, that is, volumes 1-13 inclusive, shows that data on radiation have been generously contributed to the Society's records. Only a brief outline seems expedient at this time, but it is recommended that not only this subject but the entire field of heating and ventilation as covered in the Society's books be indexed in detail to take, say, the form of a pamphlet so that the volumes may be of maximum usefulness to their owners.

In volume I is a paper by Professor Carpenter, "Testing of Steam Radiators." It is explained that the thickness of material composing the radiator is immaterial, and the rate at which heat will pass will depend entirely upon the rapidity with which heat can be carried from the outer surface. To a certain extent the character of the material of the radiator may make no difference in the amount of heat transmitted. The paper discusses in considerable detail the theoretical and practical considerations involved in testing radiators and covers work of three years' duration with the records of a large number of tests of a considerable number of types of radiators. It is noted that the coefficient per degree for a temperature difference of about 150 deg. is about 1.6 B.t.u. per square foot per hour for radiators; about 3.8 B.t.u. for 2-in. horizontal pipe, and about 5.7 B.t.u. for 1-in. pipe under the same conditions. It is somewhat difficult to enumerate all the points brought out in this paper as the summary itself occupies perhaps two or three pages of text.

In volume I is a paper by J. J. Wilson on the construction of hot water radiators. This discusses the character of iron used in radiator manufacture and the volume of water per unit of radiating surface. The discussion brings out some interesting historical facts with regard to the original type of hot water radiators and the volume of water they contained.

Only one topic of discussion relating to radiators is considered

at any length and this covers the temperature drop allowance in hot water radiators, but no specific information is obtainable.

In volume II the color of radiators as affecting the emission of heat is discussed in a topic. The opinion is that color makes little difference. It is thought that varying degrees of roughness of the paint surface may account for the difference in heat delivery, the rougher the greater the heat emission.

In volume III Prof. Carpenter contributes his method of proportioning direct radiators, a method which has had very general adoption. The rule is as follows: multiply cubic contents in cubic feet by the number of changes of air which it is expected will take place; divide this product by 55 and to the quotient add the glass surface and one-quarter of the wall surface expressed in square feet and divide the sum by 4, when the result will be the number of square feet of direct steam radiation. To determine the amount of water radiation, the calculated amount for steam is increased 60 per cent. The paper includes tests of 3-in. piping, and results obtained are 280 B.t.u. per square foot per hour for steam radiation and 175 B.t.u. for water radiation.

In the same volume, in an informal topical discussion, it is suggested that to control the amount of heat given up by a radiator one may put an automatic air valve on a middle section and a positive air cock on the end where the automatic air valve should be. By closing the air valve one-half of the radiator may be in use. Opening the air cock allows for using the entire radiator.

In volume IV is a discussion on pipe coils versus cast-iron radiators, and it covers such points as dust collection on radiators, marble tops to radiators and the appearance of radiation.

In the same volume a paper is contributed by Herman Eisert on determining the heating value of indirect radiators. It is understood that smooth surfaces give up from 2¼ to 3⅝ B.t.u. per degree of temperature difference per square foot per hour. Owing to the usual arrangements of heating surfaces in various types of radiators, he mentions that the actual results obtained are about one-third less. He maintains that even under most favorable conditions, the value of extended surface is limited. He holds that the relative value of extensions are 30 to 45 per cent. of the relative heating value of the radiator's prime surface.

He asserts that with commercial radiators only one-half to two-thirds of the ascribed value are actually obtained.

In volume V, in topical discussion, Prof. Cooley is quoted to the effect that radiators should be read not by actual measurement but by trade measurement of the heating value expressed in those terms. Prof. Carpenter favors the actual measurement, then employing what data are available to ascertain heating values. In radiators, strange to state, there is 25 to 30 per cent. more cast iron than necessary. The fact that 24-in. radiators give nearly as much heat as the same form 38 in. high is mentioned. It is stated that these radiators are more efficient than thick ones, yet most radiators are thick.

In the same volume an interesting experience is related by Mr. S. A. Jellett of a direct-indirect installation erected for Dr. J. S. Billings.

In volume VI Mr. Payne claims that the proper location of radiators is always between windows, and the failure to heat with radiators on the inside wall is reported.

On tests of radiators, Prof. Carpenter says that errors that arise are due to irregular testing conditions; the change of a very few feet per second in the velocity of air may make great differences in results.

In the same volume in regard to taking warm air from an indirect radiator casing Mr. W. M. Mackay advises taking from the top of the casing rather than from points near the top.

Tests of radiators with superheated steam are made the subject of a paper by Prof. Carpenter. The conclusion is that superheated steam is a poor heat transmitting medium. The rate of heat emission is 1.16 to 1.83 B.t.u. per square foot per degree per hour for one radiator, and 1.41 to 1.97 for another radiator with a range of pressure from 2 to 30 lb.

In volume VIII the use of a desk type electric fan with a direct radiator is described. Where the fan is 6 ft. from a hot water radiator, Broomell said that the increase in results is 20 to 25 per cent.

In volume IX the commercial feasibility of sheet metal radiators using air is discussed by Dr. G. M. Aylsworth. In one case, with the air supply at 213 deg., the return is 122 deg., and 1 sq. ft. is sufficient for 40 to 60 cu. ft. of space.

The relation of spaces between sections of radiators to the efficiency is discussed at length in the same volume.

The use of sheet metal radiators is discussed also in this volume. A case is mentioned where wrought iron radiators were taken out after 28 years' service, still showing efficiency and durability, the objection being the space required.

In volume X Dr. Aylesworth reports a test of hot air apparatus, circulating hot air through sheet metal radiation, and holds that 37 per cent. less radiation is needed than had hot water been used.

In volume XI the experience with radiators in the top story of a building is related by Capt. A. B. Reck. The building is supplied with 5000 sq. ft. of hot water radiation, mainly rated at 160 B.t.u. per square foot, and there are 80 rooms arranged on three floors. The conclusion is based on 80 deg. temperature difference. Fifty per cent. more radiation is needed on the third floor than on the other two.

In the same volume mention is made of the invention of sheet metal radiation in 1854.

In volume XII is a topic of discussion covering the advantages of placing a check valve on the return connection of steam pipe coils, and a rather comprehensive contribution is submitted showing a pipe coil with supply and return from a single riser with a light check valve fixed so that it will allow for the outflow of the water whenever it collected in sufficient volume to overcome the slight weight of the flap of the check.

In the discussion of a paper on heat losses and heat transmission of building materials the statement is brought out that it takes more than twice as much heat to heat to 70 deg. when the thermometer outside is zero than it does when the thermometer outside is 35. The fact is explained in part that the loss of heat through a building is due to two causes, one by radiation and the other by the abstraction of heat by the air in contact with the outside of the building.

In volume XIII the report of the committee on tests describes how three radiators are tested and gives 1.4 B.t.u. per square foot per degree per hour for two of the radiators and 1.5 for the third.

The rating on the rated surface of a radiator is discussed in

the same volume, with recommendation how steps may be taken to coöperate with manufacturers. A statement that radiators are overrated 20 per cent. goes unchallenged. Mr. W. M. Mackay says that some radiators are 5 to 10 per cent. short in surface, and that some four-column radiators are 20 per cent. less efficient than two- or three-column radiators.

W. W. MACON, *Chairman.*

CCXXVI.

TOPICAL DISCUSSION.

TOPIC NO. I.

Methods for Testing House-Heating Boilers to Get the Most Accurate Results.

Mr. May: Professor Kinealy, who proposed that topic, as I understand, asked the American Radiator Company if they would write a paper for presentation to this body on their method of making tests of house-heating boilers. The company said they would be very glad to do that, and delegated me to prepare such a paper. That request, however, came about one week before the meeting, but your rules make it necessary that papers so written must be sent to your Publication Committee and printed, so I told the professor that time did not permit the preparing of a paper which would be at all commensurate with what it ought to be, therefore I said that if he would present the subject as a topic for discussion I would be very glad to tell in as few words as possible the method of the American Radiator Company, as *a* method, not as *the* method, because we all know that there can be made any number of tests in several different ways that would give just exactly similar results.

Our method of tests has been the result of ten years' actual experience, day after day, wherein one method would be tried long enough to establish the fact that it was not reliable, that it did not give the data desired, and so on. There have been tried ten or fifteen different methods. Suggestions have been gladly received and followed up, and followed up until it was absolutely shown that they did not embody the true measure of a boiler's capacity or efficiency in design; that it did not give the proper way of arriving at those factors. We have finally gotten a method which we believe gives reliable results and one

which has been confirmed by all of the leading engineers abroad. It has not entirely been confirmed by engineers here, because it is a difficult matter to get an engineer to go to our experimental plant.

The American Radiator Company therefore have expended in the neighborhood of $100,000 and a building is half completed at Buffalo which is going to be dedicated to thermal research; to be dedicated to the investigation of all the particulars which go to make up a proper heating system. I may be premature in stating this, but I believe our President would bear me out, that it is the intention to invite in the future this body as well as other bodies to hold there their summer meetings, if you please, because I understand the annual meeting can be held only in New York, and there will be a department, a thermal testing laboratory, where if you so desire a test can be conducted for the benefit of any committee that may be appointed to investigate any particular condition which they may have in mind. And in that way I believe that the American Radiator Company will demonstrate to you that they are as much if not more interested in finding out the proper method of testing boilers as this body or any other body of similar kind.

President Snow: Mr. May will tell us this improved method of testing boilers.

Mr. May: I am just working into it. One of the suggestions of last night I would like to hark back to, because it was suggested as one of the tests, that the water after being brought to the steaming point should be run one hour under actual working conditions before the regular test was started. I do not know just quite the object of running it for a full hour after you have got the water to the steaming point, but that was the suggestion. Our present method for starting the test is somewhat similar to that suggestion, namely, that a wood fire be built, the water brought to the steaming point and then the wood fire rapidly withdrawn and a new fire rekindled. We, however, did make this condition: that the new charge of fuel, which shall constitute the fuel charge, shall be put in just as rapidly as firing will permit. In other words, we do not say as rapidly as possible, because if that were left to the fireman he might say that meant just as soon as the fresh coal is ignited,

and it may be two hours before he gets his full charge. We allow as a minimum one-half hour after the new charge shall be placed on. The length of run on one firing starts at the end of a half hour. In other words, the length of run does not start from the time we begin to put in the coal, but after the coal is on the fire. We make the test by feeding water from a pressure tank under constant pressure, the water line being maintained at a constant level throughout the test by means of compressed air in the tanks. The tanks are calibrated to an exact reading so that by the reading of the gauge we know at any minute how many pounds of water have been fed to the boiler.

We have tested another thing, that will, when the new department is ready, do away with the first preliminary wood fire, because it is a very dirty method and at best rather cumbersome to operate. The water will be fed into the boilers measured from a tank which has been heated to the boiling point by means of steam coils. The water is fed under pressure at practically the same rate as the evaporation is taking place, the temperature of the feed-water taken and results deduced by calculation. The readings are taken every ten or fifteen minutes simultaneously, as there are several men in charge of the plant, and from the start to the finish of the test the drafts are not regulated other than to maintain a constant draft on the draft gauge. The air inlet therefore is not touched, the fire is not touched in any way, the grates are not even sliced, so that we get an exact condition as would be found in an actual installation. We also make a test for rapidity of steaming, that is the length of time in which that boiler could be made to burn out its fuel, and its corresponding efficiency under this condition. We also make a test—and when I say a test I mean enough tests of each kind to maintain a check and an average—we also maintain a series of tests with a fire checked to see how long the boiler will carry steam, and how long a time it will carry its fire, and its results under those conditions.

It is unfortunate that some of the questions asked of manufacturers should relate purely and simply to those factors which have to do with the designing of a boiler, have nothing to do with the coal capacity or efficiency of the boiler; and naturally

the manufacturer who believes that he has got something that merits attention in the way of design hesitates to give out those factors promiscuously or even individually, but they are always willing to give out any information which they consistently can which is going to be of benefit to this body.

Now as regards the individual conditions regarding the tests, I do not know, Mr. President, that I can make that clear without a set of blueprints, which unfortunately I did not have the time to prepare. If there are any questions which any one would like to ask along the methods it would probably bring out a little bit clearer the idea.

Mr. Seward: I would like to ask, that he may give us his method of testing water boilers. As I understand it, what he has described is evaporation tests for steam boilers.

Mr. May: Our system of testing water boilers is fundamentally with tanks, with temperatures taken at all points both with the water being constantly agitated and at rest, so that we get a comparison of the two methods. With the manufacturers who handle a steam boiler and use the same steam boiler for water, the evaporative test of that boiler is just as good a measure of its capacity for water as it is for steam, but *our* principal method is in the way of heating in tanks.

President Snow: Gentlemen, the topic is open for discussion: "Methods for Testing House Heating Boilers to Get the Most Accurate Data." That brings it down to the specific question how to get the most accurate data.

Mr. Barron: If the question is in order, I would like Mr. May, if he has no objection, to explain how he gets his basis for figuring up his heating surface, and the grate surface, with the ordinary type of sectional boiler; that is, the relative value he attaches to flue surface and grate surface.

President Snow: The question is not strictly in order, but if Mr. May is inclined he may answer.

Mr. May: I would be very glad to answer if I can, but there are no two boilers which would measure exactly the same per square foot of heating surface, so that if you knew the amount of heating surface of the boiler it would have absolutely no bearing, as far as any one is able to determine, on the boiler's rating. If one could tell the individual amount of heating sur-

face, its relative position as relates to the fire, one could make an estimate as to the heating capacity. In other words, no two boilers, even though they be of the same general type and design, would have exactly, per foot of heating surface, the same capacity. So far as measuring the grate surface, we have considered the grate to represent that body where the air is admitted to the fire, the extreme limit of the air admission, not the firepot. For instance, if you will note, the American Radiator Company in their catalogue give two terms: they give the grate area in square feet and they give the average firepot area in square feet; the one for the purpose of allowing the engineer to estimate the coal-carrying capacity and the other, if he chooses, to get the rate of combustion, and from this he gets the area of what we call the grate. I have not given you very definite information, but the best I can give.

I will give you this, just as a bearing. We have found a heating surface varying in its transmissive power all the way from 2,000 to 10,000 heat units per square foot per hour, and actually doing it hour after hour and day after day. So that you can see there is a wide range of which we could make no comparison.

Mr. Chew: Mr. May, when you say 2,000 to 10,000, is part of that surface near the fire and part of it in the flue, or do you mean all the same relative distance from the fire in both instances?

Mr. May: I am taking different types of boilers. In heating surfaces one may have the same relative power as the other, but of different designs.

Mr. Seward: Mr. President, I would like to ask Mr. May if that variation of transmitting power of 2,000 to 10,000 B. T. U. per square foot per hour is on a constant rate of combustion. That seems a remarkable difference for a constant rate of combustion. If we can design a heating surface that has a transmitting power of 10,000 B. T. U. per square foot per hour on five pounds of coal burned per square foot of grate per hour, we have a remarkable heating surface; but if we are burning coal at the rate of ten or fifteen pounds, then it ceases to be remarkable and gets very ordinary.

Mr. May: I think Mr. Seward overlooked one statement

where I said that was on different types and designs of boilers. Naturally if you take the same boiler and run it at different rates of combustion there would naturally be the same relative increase at the higher rate of combustion of the absorbing power, based on the higher temperature of the fire; but it would not be an exact arithmetical progression. The line would be a curve. It was not my intention to say that this meant on one boiler it varied from 2,000 to 10,000 units.

Mr. Quay: I would like to ask Mr. May whether what they call the heating surface and what legitimately would be called the heating surface have the same efficiency, or whether there is not a difference. That is, what is sometimes called the heating surface is further away from the fire and not as efficient as other heating surface; if that is not the case in the testing of any one boiler, do you not find a difference in the heating surface as to efficiency?

Mr. May: I can answer that question in this way: I happen to remember, where in one boiler, the direct surface, or that surface on which the fire shines, developed a coefficient of 10½, whereas the flue surface, or that surface that gases come in contact with, and furthest from the fire, developed a coefficient of 2½; the variations coming down from 10½ to 2½ in the same boiler at the same time.

Mr. Cryer: Mr. May says that he starts the fire in the ordinary way with wood and coal till he gets steam up, and then he dumps the fire and starts to build a new fire, and waits thirty minutes before he starts his test. Now I would like him to continue from that point and describe how that test is made. I would like to know the temperature of the gases leaving the flue. I would like to know the method by which he pipes his boiler and gets the conditions of his test.

Mr. May: I did not say that we waited one-half hour, but I said we gave ourselves that limit. Sometimes on a big boiler it takes a long time to fill the firepot; but I did say that we set a limit in which time the coal must be put on. So if the coal were put on in ten minutes and our coal were all on, our test would start at that time.

So far as the measurement of the temperatures goes we take that by means of pyrometers, and we have all the devices which

we believe to be standard, the best that we can find, and if any one has anything better we are looking for it to buy it.

After we start the fire the boiler begins to steam. We have it piped from the top through a separator to a weighing tank, which takes any condensation which may come from the pipes. All the readings are taken on an average of fifteen minutes apart, and the averages are taken, the corrections made for condensation in the pipe, the condensation or the water in the separator, and sometimes we carry two separators in series. The different calculations, of course, are simply mathematical. I cannot explain thoroughly without a blueprint to show just how the piping goes. I would be very glad to, had I the opportunity. As to whether we carried the test under pressure, we have tried it both ways and we found that there is practically no difference in the result, so that now we depend entirely on evaporation at atmosphere.

Mr. Chew: I would ask Mr. May what percentage of moisture is carried by the steam? Is it a heavy percentage or is it simply dry steam?

President Snow: You spoke of using one separator sometimes and two at other times.

Mr. May: As far as the results we have got it makes no difference. The second separator gives the condensation practically of the first separator. The moisture that we have found to be present varies of course with the type of boiler, and when I say type of boiler I want it understood that we do not spend all our efforts testing our own boilers. We do test other boilers. And so far as I can see, those boilers which do not heavily prime—and there are very few that do that, except under extraordinary conditions—we can make them do it by using certain kinds of water; but under ordinary circumstances the amount of moisture from the ordinary average cast-iron boiler on the market rarely exceeds two and one-half or three per cent., and very often is nearer one per cent. So that it is well within the limit of the maximum set by the mechanical engineers, which I believe is three per cent. It is very rarely, except in extreme cases, that we ever reach three per cent.

Mr. Quay: I would like to know in their tests whether they get better results and better efficiency from a thin body of water

with more exposure to the fire than they do from a larger body of water, similarly to what we find in the high-pressure boiler. We find in high-pressure boilers that we get much better results with a comparatively thin body of water, not any larger body of water than the heat will penetrate. I would like to know whether the same results are found in the low-pressure tests or not.

Mr. May: I believe it will be found that the smaller bodies of water, with more rapid movement, do absorb the heat more rapidly and make the efficiency per square foot of surface higher.

Professor Hoffman: Is it assumed that all the steam that leaves the separator is dry steam, and that the per cent. of moisture is what you get out of the separators, or do you have calorimeters on the line in that way?

Mr. May: We do not take calorimeters, because our experience over a long period of time has shown that the calorimeter readings or the handling of calorimeters is extremely annoying, and it takes so much time and gives so little appreciable result, and further, as we have repeatedly demonstrated that we are well within the limit of the maximum amount allowed, we have not thought it would affect the capacity or efficiency of the boiler to that extent which made it necessary to take record.

Mr. Blackmore: I just intend to speak in relation to the calorimeter and the use of it in the matter of low pressure. As Mr. May explained, it is difficult to measure the moisture in steam at low pressure with a calorimeter. As far as the calorimeters in the market now are concerned we cannot use them with the pressure below 35 pounds, and that is a pressure at which cast-iron boilers are rarely used. I have made tests on a steam boiler with a pressure of 40 pounds with a calorimeter and made the same test at 5 pounds without a calorimeter and with a separator, and there is a difference, there is more moisture in the steam at the low pressure, even after it has passed through the separator, than there is apparently in the steam in passing through the calorimeter at 40 pounds pressure; but there is no means by which we can accurately determine how much that moisture is. It does show, however, that there is a

little more moisture in the steam at low pressure after passing through the separator than after passing through the calorimeter; but the difference is apparently so little that we can afford to disregard the calorimeter after passing through one or two separators.

The question of the use of one or two separators is a proposition on which a good deal of discussion might be made. Two separators do collect more moisture than one. But the amount collected by the second one hardly warrants the use of the two separators. One separator seems to take off all the moisture that is carried as surplus by the steam, and we get fairly good results by having one separator without the calorimeter. We cannot use the calorimeter with the low pressure carried on a cast-iron boiler as ordinarily used.

As to the question of heating surface, from what has been said here you can see its value varies so much that without a very extended number of tests being made under exactly the same conditions as are stated to determine the relative value of fire-box surface and of flue surface, we will have to be guided by practical experience. There is a factor of value in the fire-box due to direct radiation that is entirely independent of the difference in temperature between the fire and its absorbent surfaces, and while we know theoretically what it is, it has always been a difficult proposition to determine what it actually is in practice. It will take a great deal longer time than most of us have been able to give to this subject to determine this factor, but inasmuch as we do know there is a difference it is one of the things we have yet to determine.

TOPIC NO. 2.

The Influence of Low Pressure or Vapor Vacuum Systems Toward Lifting Water from the Boiler to the Mains and Radiators.

Mr. George D. Hoffman: I cannot conceive how any thinking man could ever imagine that vacuum has any power in itself. Vacuum is absence of pressure. A perfect vacuum is an empty space. In order to lift water there must be, of necessity, pressure behind it. When water flows up hill it means that the

pressure ahead of the water is less than the pressure behind it. In a steam-heating apparatus operating under vacuum where the water backs up the return, the cause thereof must be because of a higher vacuum, i. e., less pressure in the return than in the boiler, which would naturally cause the water to flow out of the boiler into the return. This higher vacuum in the return may be caused by a restricted main or a main so exposed near its terminal as to cause a distinct loss of pressure. In my experiences, I have found nine times out of ten that the lifting of water into the main was caused by restricted outlets from the boiler with a result of so increasing the velocity of the steam out of the boiler into the main that the water was carried with the steam. Enlarging the outlet always effects a permanent cure.

I have also found cases where engineers said that water was held up in the radiators by reason of a vacuum appliance being placed on the radiator. Water can be held up in a radiator in this way, provided the outlet out of the radiator is not large enough to accommodate the flow of water out of the radiator, or else the flow pipe leading to the radiator is trapped in such a way as to prevent steam or air going into the radiator to take the place of the water as it tends to flow out. I have in some of my talks made a demonstration of that particular phase of trouble by means of a bottle. A short rubber hose was connected to the nose of the bottle and the bottle filled with water. Turning the bottle upside down with the hose hanging perpendicular, the water flowed out of the bottle and the air gurgled back into it, the air taking the place of the water as fast as it ran out. But let me tip the hose up a little bit, making a trap in the hose so that the air could not get into the bottle and the result is that the water would cease to run. Where a radiator is so piped that there is a slight trap in the pipe, the condensation coming from the radiator will gradually fill the trap, and if there is in such an instance a vacuum appliance on the radiator—this may be simply a closed pet cock—then that radiator will accumulate water; it will stay there simply because neither steam or air can get into that radiator through the trapped pipe to replace any water which may tend to run out. Whenever the water stays in the radiator where a vacuum valve is used on the radiator, and runs out where an ordinary venting valve is used,

there must be a trap in connection with the flow pipe from that radiator somewhere.

Mr. Paul: I am going to take a little exception to the point that has just been made. Water will hang up in a radiator providing the supply is too small. If the velocity of flow of the steam in a one-pipe job and the connections to it are too small, the water cannot go back against the velocity of the steam coming and it will hang up in the radiator.

Mr. Hoffman: I accept Mr. Paul's correction. He is absolutely right in that.

TOPIC NO. 3.

The Amount of Water to be Evaporated to Maintain a Proper Humidity in a House in Zero Weather.

Mr. Chew: My attention was called some time ago to a residence that had about 30,000 cubic feet of space in it, and the heating apparatus was so arranged that the vapor apparatus was automatically supplied, and the water evaporated every day had been measured, and 32 gallons of water had been evaporated in 24 hours. Most people would think that if you dumped a barrel of water on the parlor floor or on the floor of any other room in the house you would have a bad effect, but here was a house of fifteen or sixteen rooms in which a barrel of water was evaporated and turned loose in the building every day.

Now take even that amount, it is not much when you figure what the change of air was in the building. It was an indirect heated building, requiring frequent changes of air and so into the question comes along, what percentage of humidity would that make when so much air was brought to that building or what percentage had it when evaporation was started in on a zero day? If the relative humidity outdoors was 50 per cent. or below that, and that air is heated to 120 degrees, it has a capacity for quite a bit of moisture, and a barrel of water a day is by no means sufficient to bring it to the right humidity, from theoretical calculations.

Professor Hoffman: Along the line Mr. Chew just mentioned, suppose we were to calculate the amount of moisture

that theoretically should be sent to a furnace heated house we would be surprised that it would be more than could be put in by any of the present methods of supplying it. I have no doubt but that if we could supply enough moisture for the entering air, the furniture and decorations in the house would be much more durable and lasting, and the people would feel much better. The humidity in the average furnace heated room is very low. It is commonly said that we should have a humidity of not less than 40 per cent., while 60 to 65 would be better. I have found a number of cases where furnace heated rooms were as low at 70 degrees as 20 to 25 per cent. When talking in the room under such conditions your lips and throat become parched and dry. People may be just as healthy under such conditions, but I believe they are not as comfortable.

Mr. Chew: I have a horsehair hygrometer in my dining room, and on a cold day when I fire up good and strong to keep warm it gets down as low as 22, and if something is not done to provide some moisture it will not get above 28 while the weather keeps cold. That has been my experience. There is objection to this condition and a little fire is started in the open grate and a tea-kettle hung so that the steam it makes gets the humidity up to about 28 per cent. A pan of water has been used on the register, but the evaporation is too slow there, unless a cloth is hung so that one end is in the water and one upon a wire rack, or something like that. When the open fire is going there is not quite so much coal burned, and yet there is comfort and humidity. Once I looked and the thermometer was 78, and I was cold, the evaporation was so great, and I looked over at the hygrometer and found it was down to 20 to 22. In this house of which I spoke, one of the points made is that those who occupy it are very comfortable with a temperature anywhere above 65, and 68 is the normal temperature of the home, and it is said it is because a barrel of water a day is evaporated.

Mr. Feldman: In a large residence, in which I installed a humidifying apparatus, I found, after a series of tests, that 50 per cent. relative humidity was found about the most comfortable and most desirable condition. The temperature of the house was kept at 68 degrees. In some rooms where the ducts were connected right over the humidifier, the relative humidity was at

times 65 per cent. This caused complaints, especially from the lady of the house, because the window curtains got a little damp.

Mr. Chew: I would like to ask Mr. Feldman a question: Was that apparatus in operation during this cold spell, and did they have any trouble with frost on the window pane, condensation from the room, or any of that kind of trouble?

Mr. Feldman: There was some condensation on the windows, but no frost.

Mr. Chew: How about the freezing on the glass?

Mr. Feldman: The condensation on windows was only in those two rooms alluded to before, when the ducts were immediately over the humidifier, whenever the humidity was over 50 per cent.

Mr. Macon: A few figures will be interesting to show the considerable amount of water vapor which must be added to the air in a house in order that, for example, the humidity may be 75 per cent. at 70 degrees. At zero and 50 per cent. humidity, 1 cu. ft. of space contains 0.54 grain of water vapor per cubic foot. At 70 deg. F. and 75 per cent. humidity, 1 cu. ft. contains about 2 grains. This shows that there has been added to the space within the house about 1¾ grains of water vapor per cubic foot. Suppose we consider a house 40 x 30 ft. in plan with an interior height of, say, 20 ft. The cubic contents are 24,000 cu. ft. Suppose we assume that in zero weather the air is changed twice an hour. Then 48,000 cu. ft. are circulated through the house in an hour's time. There have apparently been supplied to the air, if we are to realize the desired humidity, $1.75 \times 48{,}000 = 84{,}000$ grains per hour. This is equivalent to 12 lbs. One human being may give up, say, 0.07 lb. of vapor per hour. If there are as many as 15 people in the house, the human occupants will supply about 1 lb. per hour. This leaves 11 lbs. to come from the kitchen, where most of the water is likely to be boiled, or from special humidifying apparatus. There is certainly an indication that the leakage of water vapor through building walls occurs at a slower rate than air. The hygroscopic properties of building materials have undoubtedly a bearing on the question.

Mr. Collamore: There is just one point that I would like to call to your attention in connection with all these measurements

relative to humidity. That is, that they should be made in accordance with the procedure mentioned by the Government; and that is, with a sling psychrometer, and not with an ordinary hygrometer that hangs on the wall, which is misleading. In many cases you will find a relative humidity that is considerably lower where measured with an ordinary hygrometer than when measured with a sling psychrometer. I would suggest that when we measure humidities we do it with this standard instrument.

Mr. Feldman: In connection with the humidifying of a house the difficulty is this: One or two pans are usually placed in different parts of the house arranged with humidistats to generate a certain amount of moisture. This apparatus is usually at the pan. It may be set to produce a certain percentage, but that will not give a definite relative humidity in the building with various outside temperatures, because with certain humidity on some days it will get too damp in the house and on other days too dry. The proper way would be to have a humidifying pan over each indirect set, and have it controlled from the room, not at the dampers. So if it thus regulated we could obtain the proper required humidity in each room. It would be very expensive, but it can be done.

TOPIC NO. 4.

The Relative Efficiency of Exhaust and Live Steam in Heating.

Mr. Kimball: I noticed in taking up a copy of the "Heating and Ventilating Magazine" this morning an advertisement in which it states that exhaust steam is capable of doing 80 per cent. as much heating as live steam. I think that is a moderate statement in comparison with occurrences that I experienced. For instance, in a central heating plant the question of buying current instead of continuing the lighting plant was taken up, and we suggested weighing the coal burned per hour while running the engine and while the engine was stopped. To our amazement we found that there was 74 pounds of coal less used when running than when stopped.

At a large insane asylum in Massachusetts three years ago they were short of boiler capacity and they found difficulty in

heating their buildings. One Sunday especially they found difficulty in carrying heat to the ends of the building. The superintendent went to the engineer and complained. It was during midday and the only part of the plant and apparatus not running was the engines. They were started, and corridor and other lights were turned on. Within an hour the complaints about heating stopped.

Now I have heard the claim made a good many times and I have almost come to the conclusion myself, that the steam leaving a boiler may go through the engine and into the heating system without losing efficiency so far as the heating system is concerned; and I would be glad to hear the experience of any other members.

Mr. Quay: If we can heat as well with exhaust steam as we can with live steam, then there isn't any question about the advantages of isolated plants for producing power and electric current where the conditions are favorable. Especially in reasonably large plants it is a question of whether current can be produced by an isolated plant cheaper than it can by a central plant, when you consider that question of the cost of heating by live steam. And I am very certain that when the whole truth is made known there will be many more isolated plants put in (especially when there is a large amount of current required) than is being done to-day.

President Snow: Have any of our central station friends anything to say on this subject?

Professor Kent: If it is found that we can get the power plus exhaust steam heating for less coal than we can get the heating alone with live steam, then the only thing to do is look into the cause. That is, if this thing is a fact we have to look for the cause.

I once found that in a plant where they had three boilers they could generate steam with less coal by using two boilers than three. That is utterly contrary to the usual experience. I found out the reason, though, by inquiring further: that when they had only two boilers in service the firemen had to be careful to fire right; but if they ran three they were careless and left big holes in the fire. So the whole secret of the power plant and heating together taking less coal than the heating alone

may be due to the fact that when the greatest amount of coal is used the fireman does not fire the boiler in the same way; so that he is not only raising steam but heating a lot of useless air to go out of the chimney. On the other hand, it may be that to get power from the engine and use the exhaust steam would not take any more coal whatever, if the boilers were fired right in both cases, than to use live steam for heating, with the engine shut down, for the reason that all the power of the engine, after it is put into running elevators and electric lights and overcoming friction is finally reconverted into heat, which helps to heat the building, so there is no loss due to the power. The best way theoretically must be to use the exhaust steam as far as you can. It is always a waste to let exhaust steam go outside the building. Keep it in to do the heating and you have the best arrangement.

Mr. Barron: Professor Kent does not explain this matter as he should have explained it. It is merely a problem of the transformation of energy, and the B. T. U.'s that the power engine uses up are not ready to do any heating, they have been transformed into another form of energy, electric energy or something else; and E. F. Osborne, I think about thirty years ago published pamphlets—and he advocated the Osborne System of Heating—in which he showed or seemed to show that a wasteful engine, from a heating standpoint, was more economical than a high-class engine. If you have a certain number of B. T. U.'s and use them up in an engine you do not get them to use further on, and do not improve your system in any way or manner by trying to do so.

In other words, the engineer must consider whether it would be best to use a plain slide valve engine more or less wasteful in steam economy in connection with a heating system as Osborne seemed to advocate or to use a high class automatic engine working at the highest attainable steam economy. Of course the problem is a very complex one, as interest on plant and fixed charges along with many other considerations determine the engineer's choice. What I wish to point out is that the law of conservation of energy and the mechanical theory of heat transformation proves that exhaust steam at the same temperature as live steam has no higher radiating transmitting efficiency.

Mr. Kimball: Referring to Mr. Donnelly's statement about the different amount of heat required during day and night on account of the different conditions in the building, I cannot imagine any building where the conditions are more uniform than in an insane asylum, where 2,000 patients or occupants of that institution are confined under restraint and are practically in the same condition day and night. And yet even there, with the light plant running in the afternoon, say, in December and January, at the time our records were obtained, they were burning less coal during the running of the engine than during the stop period of the engine. It may be worth stating that the horsepower required for the engine was only about one-third of that required for the heating. It is probable, of course, referring to Mr. Barron's statement, that only about ten per cent. of the heat units are used in the engine itself, developing energy. In the case I speak of the engines are located in an isolated building, so the heat of the engine itself is not used in the building, despite this fact there is less coal used when running the engine.

I can duplicate this experience in a plant where a lighting plant was installed. The plant had run for four years without the lighting plant. The lighting plant was then installed, and despite the fact that weather temperatures were no higher than the year before they burned one hundred tons of coal less.

Professor Kent: I will ask Mr. Kimball to explain why that was so.

Mr. Kimball: I cannot explain it.

Mr. Quay: The quality of the exhaust steam has a great deal to do with its efficiency. From some preliminary tests we made a few years ago as to the value of exhaust as compared with live steam, we found it varied one or two per cent., as near as we could tell, and we accounted for that on account of there being a certain amount of oil or foreign matter still in the exhaust steam. And I think that no engineer will disagree with the fact that exhaust steam is just as valuable, when you get the foreign matter out of it, as live steam is for heating purposes, but no doubt some would question the statement that it is of more value.

Mr. Stevens: As an engineer and designer of central station plants we have had considerable experience on this line, which has proven to us that the value of exhaust steam for heating is

considerably in excess of that of live steam. We have in many instances plants operating in connection with electric light plants. In a number of instances the total exhaust steam from the engine has been used for heating, and after the engines were closed down it was necessary to add other boilers to maintain the heating circulation or the pressure in the heating mains to supply the heat alone. Now, so far, we have no good, plausible, acceptable reason for this. My idea of it is that the economy comes not from the work of the engine, but is in the efficiency of the boiler under the different conditions. We find that by using the exhaust from a turbine engine we get exactly the same result as by using the live steam; but by putting the steam through a reciprocating engine, we get entirely different results.

Mr. Barron: As I understand it, the question really before us is the relative value of exhaust and live steam for heating. At the same temperature and pressure there is no difference in value. Any statement to the contrary is an absurdity, to my view. You take exhaust steam from an engine and utilize it for heating and you cannot possibly get any more heat out of it than the limit; you get the B. T. U. out of it by condensation, and nothing more. You take live steam for heating and get exactly the same results. The confusion of thought I think comes from the fact that was pointed out at almost the very inception of heating engineering in Baldwin's book about thirty years ago, that the average engine is only about ten per cent. efficient. So in exhaust steam you have about 90 per cent. of the thermal value to do the work.

TOPIC NO. 5.

The Objection to Placing Dampers in Heat and Vent Flues of a Fan System, Reducing Their Area

Secretary Mackay: I suggested that topic, for the reason that while this Society spent a good many years of hard work in trying to and finally succeeded in getting a ventilating law adopted in New York State, still to-day you see in the requirements of architects for school buildings the necessity of placing dampers in flues leading to the rooms and also leading from

the rooms, for two purposes: to reduce the air and to make a more uniform condition in the distribution of the air; but it also places in the hands of a careless or ignorant janitor, or perhaps a school teacher, the cutting off from the children in those rooms of the air that is provided for them by law. And it seems to me that the flues could be so arranged and the heating apparatus so placed that it could be prohibitory to put dampers in flues that would interfere with the possibility of ventilating those rooms according to the State law. I know they say air is a peculiar substance, that you must have dampers and must reduce the volume of air and must have those arrangements down in the basement where a ten-dollar-a-week janitor can prevent the carrying out of all the State laws that have ever been written.

I think we, as a Society, should protest against it, and if we have not got our arrangements for moving air down to a science we ought to have. If the matter of placing the air inlets is going to make it necessary to place dampers we should place them at some other point where there will be no necessity of working against the State laws.

Professor Kent: I would like to ask Mr. Mackay, when we have a school building built as well as we can, and then find that some flues take a greater amount than their share, how we are going to restrict it unless we allow some sort of a damper to be put in.

Secretary Mackay: I will grant what Professor Kent says is true, but I do not think it is necessarily true. I know school buildings where they do not have dampers and do not allow them in their flues, and they get a proper distribution. To my mind it is a wrong application of the heat, compelling heat to be driven long distances. It is done in this State and in many States. I know of many cases arranged so that each flue cannot help but get its proportion of air. I know there is a strong sentiment on the other side, that it is necessary to work against Nature's laws; that it is necessary to have dampers to distribute the air.

About forty years ago, when I first went at the business, it was impossible for an engineer to so arrange a hot-water system that it would not be interfered with. It was necessary to put

gate valves along the lines so as to get an equal distribution. The first time one of these ten-dollar-a-week janitors closed one of these valves it knocked out a uniform distribution. And when they get the same thing in school ventilation I think it should be prohibited or else I think we should know more about it, and not necessarily use fan-blast coils and other appliances, because our grandfathers used them.

I think we are in a progressive age, and if there is anything that is wrong in our systems, and if there is anything that takes the control of them out of the hands of the engineer and puts it in the hands of the janitor, it should be stopped.

Mr. Quay: I think the last speaker is right. The dampers are generally used in ventilating systems to overcome the error in proportioning the system. A system can be designed so that each branch and register will get its proportion of air at the right temperature without the use of dampers. Air splits, fastened stationary, after they have been properly adjusted and set are preferable to dampers. I think as far as possible dampers should be eliminated, that can be manipulated by people who do not understand them, as they often are made to interfere with the proper operation of the plant.

Mr. Lewis: I know of the heating and ventilation, I suppose, of seven or eight hundred school houses. I think there are very few of those buildings that from the time the plant was first installed and completed did not have some rooms that were not occupied. Our cities have, when they built buildings, located them out around the residence districts, and they perhaps only occupy five or six rooms during the first two or three years. It is necessary that they have dampers so as to shut off the rooms that are not to be used. Sometimes, for instance, certain rooms in high schools particularly are used for night schools and they do not ventilate the balance of the building. It is necessary to shut off the unused rooms, and for this reason I do not see how we are to eliminate dampers.

Mr. Mobley: I have cases where, after they ran several years, they placed the registers on the inside and shut them off, and as far as I know they never opened them afterward. They said they did that because it was a waste of heat all the time.

Mr. Lewis: I would like to add that it is very good practice

to seal the dampers in order to make the devices for operating them difficult of access, so that only authorized persons can find them.

TOPIC NO. 6.

The Relative Cost of Operating Vacuum Systems of Exhaust Steam Heating per 1,000 sq. ft. of Direct Radiation with 5, 10, 15 and 20 in. of Vacuum.

Mr. Quay: Two or three years ago I put a steam meter on the steam main supplying an adjoining building. The building was heated by exhaust steam. They were also furnished live steam to operate a fire pump and a vacuum system, and for some other purposes. The owners could not agree on what this steam was worth, so they put on a steam meter to measure it. When we started the vacuum system, which was supplied through this meter, I was very much surprised to find the amount of steam it took to operate this vacuum system. I do not believe it is generally known how much steam it takes to operate a vacuum system of heating, and I question whether there is as much economy by their use as is often claimed when the cost to operate the vacuum system is considered.

Mr. Feldman: In relation to the power taken for operating machines to produce vacuum, Mr. Quay thinks the exhaust of those machines is wasted. The usual way to use a pump for vacuum for exhaust is to turn the exhaust steam from the pump back to the main line and utilize it.

Mr. Quay: I think I must have given a wrong impression in what I said. I did not mean to claim vacuum systems were not of great benefit; and as the last speaker has said, where you use vacuum pump the exhaust steam can be saved. This system I referred to was not operated by a pump, and the steam to operate it was wasted. It was merely one case that came in hand that I had a good chance to test and was surprised at the amount of steam required to operate it. But this is not a condemnation of the vacuum systems. I did not mean to state that. You get economy provided the proper provision is made for using the exhaust steam, especially where you use economical pumps. I do think that they have not used as much care in the selection of

vacuum pumps as they should. You scarcely ever find a compound vacuum pump, and I do not know whether there is any satisfactory one on the market or not; but you often find the pumps that are used requiring a great deal more steam to operate them than they should use. If all the exhaust steam is all used in the heating system, then there is not much waste.

Mr. Stevens: I think the answer to Mr. Quay's question is entirely in designing the vacuum system. If the return from your heating units is allowed to go to your vacuum pump at the same temperature at which it leaves the radiator, or practically so, and be cooled at the bottom by a jet of cold water for the purpose of maintainig your vacuum, then your vacuum is unquestionably more expensive than the ordinary low-pressure steam-heating system. But if these returns are carried through a series of cooling coils, boxed in as we would box in direct radiators, passing cold air over the coil and extracting the heat from the water, this heat being used or from an indirect radiator, the air and the water being separated before they get to these coils, you will find the vacuum system is very much more economical than the low-pressure system.

Mr. Barron: I have learned that 20 inches of vacuum is more efficient in a heating system than 10 inches. Somebody may dispute that, from the general run of engineers' knowledge of such plants. I have put in a good many different kinds of systems, and the general experience of men who are running them is that they can get better results than with 10 inches. That is a matter of opinion.

Mr. Quay: I think the gentleman is mistaken about 20 inches of vacuum being the most efficient. There are several reasons why low vacuum is better than high. It is very hard to get return valves that will stand the high vacuum, and if they leak you are going to draw a large amount of steam back through the system, which is not the economical way to heat a building. The steam should be condensed in the radiator. Tests have been made to secure the best results, and other things being equal, low vacuum gives much better results than high vacuum. Of course when the system is wrong, or if you have to lift water over doors, etc., then you need a higher vacuum. But you lose efficiency where you have to carry a high vacuum.

Mr. Webster: Mr. Chairman, I am very much interested in the question, and I was wondering how it would be answered. We have been about twenty-two years in that business, and we find it very difficult to formulate specific rules that would apply everywhere as a general proposition. We found that it was necessary to examine each particular case so as to determine what would be required. There are a number of points to be considered: First, as to the amount of radiation; second, as to the sizes of pipes of the supply and return lines, and, third, whether they are all gravity returns or lifts required to be handled at different points. In giving my version of that question as to the degree of vacuum, we endeavor to get at least two inches of vacuum at the return end of the most distant radiator from the source of steam supply, by maintaining a sufficient degree of vacuum at the pump which will give that as a net at the most distant radiator—the delivery side of the automatic return valve connected at the return side of the most distant radiator from the source of steam supply maintaining a differential of at least two inches between the steam supply main and return. To maintain the above, it may require six inches of vacuum at the vacuum pump. Then we set our vacuum governor accordingly. In cases where there are heavy lifts it may necessitate, in order to get that result, as high as twenty inches of vacuum at times, varying according to conditions.

In gravity conditions we may get along with three or four inches vacuum at the pump, to give us a net of two inches at the radiator. This is our method for determining degrees of vacuum required for the most economical performance of steam circulation.

Now, in regard to the question of quantity of steam used by vacuum pump in order to produce a vacuum, that depends upon the make and type of pump, also upon the kind of return valves that are used and their efficiency for retaining the steam within the radiator and permitting the water and air to be drawn therefrom.

At first it was very true it took very large pumps, where the leakage of steam from the radiators to the return was very great. Return valves were improved, until we claim now about 99 per cent. efficiency, as can be shown by tests to any one that

is interested, and vacuum systems can be operated without the use of jet water.

About twelve years ago we made some tests to determine the quantity of steam it required to operate steam vacuum pumps, as compared with the quantity of steam circulated through the heating system to which the vacuum pump was attached, and we found the quantity to vary from one per cent. to five per cent. (according to type and make of pump) of the amount of steam condensed in that particular heating system.

I believe I have answered the questions according to my knowledge of the subject.

TRANSACTIONS

OF THE

SEMI-ANNUAL MEETING

St. Louis, Mo., June 30–July 1, 1910.

CCXXVII.

PROCEEDINGS OF THE SEMI-ANNUAL MEETING,

St. Louis, Mo., June 30 and July 1, 1910.

PROCEEDINGS.

First Day—Morning Session.

(Thursday, June 30, 1910.)

The meeting was called to order at 10.30 A.M. by President Hoffman.

The Secretary announced the names of the following persons who have been elected to membership in the Society since the last meeting:

E. E. Baker	Member
J. Bidwell Blake	"
Herbert H. Brooks	"
Frederick K. Davis	"
William F. Devendorf	"
Robert L. Folsom	"
Edward E. Fox	"
Harry E. Gerrish	"
Charles A. Haslett	"
William Read Heick	"
B. R. Hull	"
Henry H. Lee	"
A. B. Marshall	"
Charles Morrison	"
Charles L. Pillsbury	"

S. Whitmore Robinson	Member
John D. Small	"
Charles H. Staten	"
Eugene Arnold Vivarttas	"
George B. Wallace	"
Frederick A. Wilson	"
Harry de Joannis	Associate
W. Harwell Allen	Junior
George E. Grimshaw	"

After the Secretary had called part of the roll the President stated that there was a quorum present, and on motion the further calling of the roll was dispensed with.

The President then read his address as follows:

PRESIDENT'S ADDRESS.

As the President of the Society I extend to you greeting and words of appreciation on the evident increasing interest that is being shown by the individual members and their friends in the affairs of the Society. It is not only fair and proper to congratulate you upon your past record, but it is fitting at this time to felicitate with you upon the prospects of the immediate future. The membership of the Society, their officers and committeemen, have all had a part in advancing the good name of the Society, and have placed it in a position where it is doing good work. As a result of this, the growth of the Society has been steadily upward. At the last annual meeting there were a total of 367 members in all grades. Three failed to qualify and seven resigned, reducing the number to 357. Of this number, 14 were dropped for non-payment of dues, giving a net membership of 343 preceding the last ballot, which, with its twenty-nine new names, makes a total enrollment at the present time in all grades, of 372. This is the largest enrollment in the history of the Society. In addition to this the Secretary has received seven applications for membership since the ballot went out, three of these being from St. Louis. A number of men, not identified with the Society, have been asking concerning

membership, and have expressed a decided interest in favor of the Society, and I have every reason to believe that before the end of the year our membership will reach above the four hundred mark. With all our ambition to increase the Society's membership, however, it is not alone the number of men that we are looking for. We want numbers to be sure, but with the numbers must come the quality. The strength of any Society is not so much in its numbers as in the spirit and the enthusiasm of its members. Concerning the financial resources of the Society the Treasurer has about $1,500 on hand. One thousand and two hundred dollars are still to be paid in on old membership dues, and the new ballot brings in $750 more, making a total of $3,415, which shows that our organization is in first-class condition.

I feel called upon to-day, even though I am saying the things you already know, to speak of the position the Society now holds in its relation to the general public, and the accompanying possibilities for valuable public service. As members of the Society we all have a just pride in its advancement. It has accomplished many things, but the opportunities just ahead are now greater than ever before. As a farmer, when he wishes a crop, first prepares the field, so, giving due credit, these opportunities are presenting themselves to us, in large measure, because of the forces set in motion and the agitation caused by the members of this organization in previous years. Reforms are now working that a few years ago gave little if any evidence of fulfillment. Public opinion is now, however, tuning up to the pitch where it is asking for information. The public health and comfort is a subject that was never so much discussed as now. A few years ago the engineer with advanced ideas was always met with the statement, "the old methods are good enough for me," but now the attitude is, "isn't there something a little better?" The old expression, "you will have to show me," is giving way to, "we want information." To be convinced of this fact one has but to read the daily and scientific papers. The campaign of education, agitated first by specialists, is now being assisted and backed up by those who are not specialized in the work, but who, nevertheless, are interested in the public welfare. I can see that the influence of this So-

ciety has been very marked in having caused, in a quiet way, a very great amount of this change.

Our organization has for one of its fundamental principles, the preservation of the public health, and hence the Society is naturally regarded as the organizer and leader in such movements as will bring about such results. To be effective this organization must be united, to a man, in advocating *principle for principle's sake*. Private gain is a splendid thing, and it is right that every man should look for his legitimate share, but the cause of humanity is above the cause of any one man. The public confidence is obtained and held only in so far as the public is convinced of absolute sincerity to honest principles.

It is safe to say that these reforms for the benefit of the public health and comfort do not come by chance, but rather through the untiring efforts of men who enter the work with the idea of sacrificing some personal gain in a business way. The whole remuneration in such a case should be, the satisfaction of having done a good and beneficial thing. We have two extremes, one, living for our own pleasure of living, the other, living for the pleasure of seeing the other fellow live. A good many men in this world, I am sorry to say, live on the first plane and only too few upon the second. A happy mean exists between these two extremes, wherein one takes enough of his time from those things that are somewhat selfish and personal and uses it with the same strenuousness towards improving conditions for those who are less favorably placed. Such principles as these, when carried out, develop what we call public-spirited men, and may be known as philanthropy, but I prefer to call it just plain every-day *fair play*.

To illustrate my point, we have merely to refer to the one topic which is so universally discussed at this time, i. e., *pure air*. The general public has never before been so thoroughly in sympathy with the idea that this is probably the greatest health giver at our command, and that all persons, no matter what their occupation, should be so surrounded with conditions that they will have an abundant supply. In this free country of ours it would be rank heresy to speak of the employer as owning the employee. This would be taking a step far backward, but I venture to say that in very many cases, if the employer

actually did own those who worked for him, he would pay more attention to their personal welfare than is done at the present time in some of our closely crowded workshops where men and women are compelled during one-third to one-half of their entire time to forfeit that greatest of blessings, pure air.

I wish to congratulate the Society and particularly the committees working upon this subject, and to express my confidence that such work will be effective. As an organization you stand for just the things that have been mentioned above, and it is a credit to this body to see the unselfishness with which the work is being done. The success of your efforts is not always what you expect or what you deserve, because your energies are directed against customs of long standing, but my advice is to keep everlastingly at it, and you will be surprised at the results. No man expects *everything* to come his way, no matter how hard he has striven. I am sure it would be unfortunate if such were the case, because he would soon lose his keenness of observation and his generalship from such easily won successes.

Another line of work which falls within the scope of this Society, but unfortunately a line upon which little has been done as yet, is that of research work under the direction of the Society. This would require a fund of the Society money set apart for purely research work. The proposition is a good one, as probably most of us would agree, but so far the funds have not been available. Much valuable research work has been carried on by individuals, to whom we are greatly indebted, but there are many purely scientific investigations that do not appeal to the individual that would be great additions to our fund of information, if we could but provide for it through the Society's committees. I do not know whether or not we have arrived at the point where the members are sufficiently enthusiastic to propose that such a fund be started or not. It is a subject nevertheless that will be worth our serious consideration.

Finally, I wish to express the hope that you will make this meeting the most pleasant and profitable summer meeting that the Society has ever had.

Secretary Mackay: I am requested by the Board of Governors to announce that the ballot on the amendment of February 3 was opened and the amendment was carried. Total votes cast, 147; negative, 9; affirmative, 138; necessary to carry, 98. Article XI as amended now reads:

ARTICLE XI.

AMENDMENTS.

Proposed amendments to this Constitution and By-Laws must be presented in writing at a regular meeting of the Society, signed by at least three members, when if approved by a majority of the members present, the Board of Governors shall have copies of the proposed amendment sent to all members, together with the reasons why it is thought desirable by the members presenting same, that the changes should be made. The question of its adoption shall be voted upon by a letter ballot in the manner prescribed for election of members.

If two-thirds of the votes cast are in favor of the proposed amendment, it shall be adopted.

The President: Before Mr. Macon gives his report on New York State legislation, I want to read a private communication which came to me from the chairman of the Committee on New York Legislation, Mr. D. D. Kimball, in which he expresses his regret that he will not be here to-day, and wishes to express his thanks to the committee and especially to those who were very close to him in the work. The Secretary and Mr. Macon, I believe, were expressly mentioned. He says that whatever success they had in the work before them or in New York State was attained by good, honest and consistent effort. And I take this as a means of expressing this information to you from a private communication.

Mr. Morrin: Mr. President, in regard to State legislation in California, I have to state that while I have no written report prepared, we have the work well in hand there and have it up to the present State officials, who, on the whole, have advised us not to make a campaign issue of the law, but work quietly, and that will do it the most good when the proper time comes; and we feel that the next legislature will pass us a good law, as good as any State possesses at the present time.

Mr. Macon: As President Hoffman has practically explained in his remarks, the members of committee worked, but the state-

ment is not to detract from the work of the chairman, who gave a remarkable amount of his time and energy. The report is:

Report of the Special Committee on Legislation in New York State.

The committee met at the Engineers' Club, New York, on Thursday evening, February 24, and organized. The chairman of the committee was instructed to confer with the State Factory Inspector, Mr. W. W. Walling, and notify him of the organization of this committee, to explain to him its object and seek to arrange for co-operation between this committee and the Department of Labor in an effort to secure the passage of a bill for which purpose the committee was appointed.

This conference was held on February 25 with Commissioner of Labor Williams and Mr. Walling, both of whom expressed themselves as pleased with the plan proposed. They also agreed to arrange for a tour of inspection by the committee with one of their deputies, which was deemed necessary in order that the committee should be properly informed of the nature of the subject in hand. Also the committee was invited to witness tests of window ventilators.

The tour of inspection was made by two members of the committee who also witnessed the tests of window ventilators, of several different makes, at No. 402 Lafayette Street, New York, on March 10.

Following this we were informed by the Commissioner of Labor that he was preparing a draft of a bill covering the subject of ventilation and temperature in factory workrooms to take the place of the present section on ventilation in the law. This statement was made orally and by letter, and the assurance was also given that no bill would be perfected or introduced until we had jointly met and discussed the matter.

On April 13 we learned that a bill drafted by the Department of Labor had been introduced into the Legislature on the afternoon of April 11.

We immediately communicated with the Commissioner who communicated with us on the 14th, and a conference was held

between four members of the Committee, the Commissioner of Labor and the Factory Inspector on April 15. The bill drafted by the Commissioner of Labor undertook to establish an entirely new method of determining ventilation and the attitude of the Committee is thoroughly explained in statements issued by the Committee to the members of this Society in this State and to the members of Legislature, these statements being made a part of this report.

The Committee decided, after careful consideration following this conference, that it could not accept for the Society the method and bill proposed by the Department of Labor. It was at first decided to introduce a new bill, but later this determination was changed to an attempt to secure an amendment to the bill of the Department of Labor, failing which it was decided to attempt to defeat the Department of Labor bill in the belief that it would place us in a better position to secure a proper bill next year.

In our effort to secure the amendment and finally the defeat of the bill of the Department of Labor very serious difficulties were encountered and a most strenuous campaign was required and carried out. The statements referred to above were issued in the course of this campaign, and it finally seemed necessary to employ an attorney to represent the Committee at Albany. Mr. Bryant Willard was so employed, and his work at Albany was very satisfactory and apparently fruitful. The co-operation of several members of this Society was secured, some of whom did splendid service, other friends of ventilation were interested, and also did good work. We would especially mention in this connection Mr. L. R. Hoff, manager of the H. W. Johns-Manville Company, and more especially his associate, Mr. P. J. Baker, who did for us the most valuable and most fruitful work of all at Albany, and all without expense to the Society. We wish to refer especially also to the co-operation of the New York branch of the American Association for Labor Legislation, who actively co-operated with us, and to whose efforts a large amount of credit is due. Mr. Macon, Mr. Chew and Mr. Mackay of the Committee appeared before the Legislative Committees.

In the course of our campaign many letters and telegrams

were sent to various people, particularly to the members of the Committee at Albany in charge of the bill, and especially to Senator George A. Davis of the Senate Committee refuting the statements of Mr. Allan Robinson, of the Allied Real Estate Interests, charging the Committee with opposing the bill because of its desire to force the use of particular appliances controlled by members of this Society.

As the session of the Legislature neared an end it became evident that we could not secure the passage of the amendment to the bill of the Department of Labor as we had wished, and our determination to defeat the Department of Labor bill was fixed. Finally on May 19 the Commissioner apparently realizing the effect of our opposition expressed willingness to accept a modification of the bill comprising his proposed standard and our standard, but investigation proved that it was too late to bring about an amendment of the bill, and the Legislature adjourned with no bill passed.

To all those who co-operated with the Committee, and especially to the President of the Society and the Executive Committee we wish to express our sincere thanks. It is the recommendation of this Committee that a similar committee be reappointed to carry on the work entrusted to this Committee, the belief of the Committee being that the next session of the Legislature would be an especially opportune time in which to secure the passage of a proper bill. Our suggestion to such committee would be that they regard the experience of this Committee as a basis for the work of the new committee, which should be instructed to introduce a bill within the first month of the opening of the coming session of the Legislature. Prior to the drafting or preparation of this bill the committee should solicit the co-operation of the Department of Labor, the Allied Real Estate Interests and the American Association for Labor Legislation, and also similar bodies which may be brought to take an interest in this work. These conferences and the work of the committee should be started very early in the fall to give plenty of time to conferences, study and considerations of all conditions and considerations involved to the end that a bill satisfactory to all can be presented to the Legislature with the endorsement of all interested if possible.

It would be desirable that this Committee be authorized to expend the sum of not exceeding $250, and also that the Committee be authorized to raise additional funds by subscription if it should seem desirable.

(Signed) D. D. KIMBALL, *Chairman*,
C. B. J. SNYDER,
W. W. MACON,
WILLIAM M. MACKAY,
R. C. CARPENTER,
FRANK K. CHEW.

June 20, 1910.

APPENDIX.

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Organized, New York, 1894.

Incorporated under New York State Laws, 1895.

To promote the arts and sciences in connection with heating and ventilation, to establish a clearly defined minimum standard of heating and ventilation for all classes of buildings and to favor legislation compelling ventilation in accordance with the standard.

AMENDMENT TO FACTORY VENTILATION LAW.

The American Society of Heating and Ventilating Engineers at its last annual meeting directed the appointment of a special committee to promote the passage of a bill by the Legislature of the State of New York to remedy defects believed to exist in the present Factory Ventilation Law. The appointed Committee immediately conferred with the State Commissioner of Labor and learned that he proposed to introduce such a bill into the Legislature. The co-operation of the Committee was offered and welcomed. The value of such co-operation is apparent. We were then and later positively assured by both Commissioner Williams and Factory Inspector Walling that before the bill was introduced the Committee would be given ample time to consider and confer with the Department on the bill. Repeatedly the assurance was given that the co-operation of the Committee was welcomed, their advice desired and that ample time would be allowed for this.

The bill was introduced by the request of the Commissioner on Monday, April 11th, the Committee heard of it indirectly on Wednesday, the 13th, the Commissioner was written the same day, but up to date the Committee has had no explanation of the rejection of its proffered aid to the Commissioner.

The Commissioner's bill was introduced by Senator Davis, in the Senate as bill No. 1008, and was referred to the Committee on Judiciary. It

aims to amend section eighty-six of the present factory law, and in brief provides that proper ventilation shall be deemed to have been provided in a factory workroom when the air therein shall not contain more than ten parts of carbon dioxide in ten thousand volumes of air between nine a. m. and four p. m., and fifteen parts at other times, and that the temperature must be between fifty-five and ninety degrees. The remaining features of the bill are largely administrative.

Careful consideration was given by the Committee to this bill and other engineers were conferred with. A conference with the Commissioner of Labor was held on Friday morning, April 15th, and the method of fixing the standard of ventilation was carefully considered. Certain suggestions were offered by the Committee, but we were met by the Commissioner's statement that he would consider no modifications of the bill as introduced, that it was his bill and he must stand by it.

This bill not being satisfactory to the Committee and other members of the Society consulted, the Committee for reasons given below, had to consider either introducing an opposition bill or securing satisfactory amendments to the present bill. The Committee rules that all factories having less than one thousand cubic feet of air space for each occupant and each foot of gas burned per hour, shall be required to provide means of ventilation to the extent of one thousand cubic feet of air per hour, but that factories having over one thousand cubic feet of space per occupant and foot of gas burned and exposed window and door area equal to one-eighth of the floor area shall not be required to provide artificial means of ventilation.

The essential difference therefore lies in the method of determining the standard of ventilation to be required. That proposed by the Commissioner's bill is regarded as an innovation without warrant and open to multitudinous objections, one that will result in untold confusion and uncertainty to property owners, tenants, engineers, manufacturers, contractors, and to the Department entrusted with its enforcement. It is entirely contrary to the practice of every other state having a ventilation law and to practice abroad, also to the practice of this state in its school law. It involves a method of testing familiar to very few, even among engineers; it requires an expensive instrument, the reliability of which is seriously questioned; the test itself is a very delicate operation and one easily disarranged. Only experienced operators can obtain correct results. Carbon dioxide is not a poison, but is usually an indication of the quality of the air; in exceptional cases it may much exceed the proportion of the air specified and still the air may be good, or by artificial means the proportions of the carbon dioxide may be lessened and the air may still be bad. The bill does not specify how many samples of the air shall be taken or where in the factory such tests shall be made. A little carelessness on the part of the person testing will condemn a factory improperly. It makes possible the acceptance or approval of methods of ventilation which are dependent wholly upon weather conditions, the tests of which will result in their acceptance or rejection according to weather conditions. Thus an advantage is given to the manufacturer of questionable ventilators and to irresponsible ventilating contractors, who will take the greatest risk, and the reliable contractor, whose system will ventilate regardless of weather conditions, stands no chance in bidding in competition.

It makes fraud and injustice easily possible, the means for detecting which are not readily available to the owner or contractor. It may be made to do serious injustice to the property owner.

Every premium is put upon fraud. In no respect is this bill better than the present law.

The amendment to be urged by the Society's Committee proposes a method of determining the standard of ventilation, which is in no sense an innovation, is endorsed by every State having a ventilation law, by many foreign countries, a method in use by engineers and physicians the world over, and something intelligible to all. It may be easily tested with the anemometer, an instrument relatively inexpensive, in common use, reasonably reliable, and itself readily tested. There is nothing difficult or delicate about the test nor is special skill required. The standard provides a specified amount of air equal to the minimum required by the Commissioner's bill. It is absolutely independent of weather conditions. Fraud in the making of tests may be easily detected by the owner or engineer.

It is believed that the Committee's idea will involve less expense to the property owner because it expressly excludes certain classes of factories where experience and tests have long since shown that artificial means of ventilation were unnecessary.

That the Committee's method is a workable one is proved by the experience of other States having a similar law, the experience of other countries, the U. S. Navy Department, and the experience of thousands of ventilating engineers. No valid objections have been offered to this scheme.

It has been intimated that the Committee and the Society is animated by a desire to increase the sale of mechanical ventilating apparatus. Such an insinuation is unfounded and uncalled for. With the bill as proposed or amended the same amount of ventilating apparatus will be required. The Committee is charged with the duty of, if possible, securing the passage of a proper law, and no member of the Society, the Committee or the engineering profession will profit in one way or another, whatever may be the law. A proper and enforceable law is urgently needed. The condition of many of the factory lofts is lamentable. Nothing would do more to bring success to the anti-tuberculosis fight. Nothing would do more for the uplift of the laboring people. But the law should be simple, explicit and workable.

New York, April 25, 1910.

(Signed by Committee.)

AMENDMENT TO FACTORY VENTILATION LAW.

At the last annual meeting of the American Society of Heating and Ventilating Engineers, a national organization, organized for the purposes stated above, a Committee was appointed to draw up and promote the passage of a bill by the Legislature of the State of New York to remedy the defects believed to exist in the present factory ventilation law.

The Committee has already in a separate printed statement explained how the Commissioner of Labor has caused to be introduced a measure which the Society cannot wholly endorse, and regarding which it expected to give its best advice in response to the Commissioner's offers, although ultimately the promised conference arrangement was not made.

The Commissioner's bill was introduced by Senator Davis in the Senate as Bill No. 1008, and referred to the Committee on the Judiciary. This bill has also been introduced into the Assembly, by Mr. C. W. Phillips, and was referred to the Committee on Labor and Industries. It aims to amend Section 86 of the present factory law, and in brief provides that proper ventilation shall be deemed to have been provided in a factory workroom when the air therein shall not contain more than 10 parts of carbon dioxide in 10,000 volumes of air between 9 a. m. and 4 p. m., and 15 parts at other times, and that the temperature must be between 55 degrees and 90 degrees. The remaining features of the bill are largely administrative.

The Society commends the bill except with respect to the method it offers for considering and pronouncing whether or not a factory is properly "ventilated," but in that respect believes it to err so seriously as to nullify all its beneficial features. This Society also offers later in this communication as an amendment to the bill a substitute for that method in line with standard and well-established practice.

Attention is called to the following:

1.—BILL 1008 MAKES VENTILATING EQUIPMENTS POSSIBLE WHICH MUST SOONER OR LATER BE CONDEMNED.

The State virtually says to the factory owners: Provide a ventilating equipment and thereafter we will test the conditions of the air which it establishes in your factory. If less than 10 parts carbon dioxide are observed we will approve the installation, and consider the factory well ventilated; if more, we will not do so.

On the particular day of the test, therefore, the ventilating equipment must make good.

Devices intended to overcome the shortcomings and disadvantages of open windows are placed below the raised lower and above the lowered upper sash. Through openings in them air is supposed, and on a windy day, actually does enter and leave the room; also when the weather is extremely cold outside, there is a moderate although greatly reduced flow of air out of the top opening and in through the bottom one—but on a moderately quiet and only fairly cold day, such a device becomes entirely inoperative. Where, therefore, shall the occupants of the loft or factory get their fresh air?

Suppose the equipment to be complete. The inspector goes to the building with his testing instrument. If a high wind is blowing outside, or it is very cold, causing a considerable flow of air, the test shows the proper degree of purity in the loft and the approval to which the owner is entitled under the law is given; he pays for the equipment and considers the incident closed. Some time later the State makes another test (for Bill 1008 requires that the proper degree of ventilation must be continually maintained). At this time the wind and weather conditions are not as they were before. The "ventilators" are inoperative and the test shows twice the amount of impurity allowable under the law. Result: Condemnation of the equipment, the owner's investment is wasted and he must finally provide some form of equipment which will be efficient in all conditions of wind and weather.

Ventilation means fresh air supplied in unvarying quantities, all the time,

regardless of weather, wind or temperature. Should not the basis for acceptance or approval therefore be the cubic foot of air?

2.—*BILL* 1008 *INVOLVES FACTORY OWNER IN NEEDLESS EXPENSE.*

If the above analysis is correct it makes inevitable the condemnation and removal of ventilating equipments purchased and paid for, the results of which have under certain weather or temperature conditions satisfied the legal requirements. In such case the providing of an equipment of a positive nature to replace the other involves, of course, additional expense.

3.—*BILL* 1008 *OPENS THE WAY TO FRAUD AND GRAFT.*

Suppose that for reasons of economy an owner served with an order to ventilate a factory put in an equipment of window devices, which ventilate only under certain wind and weather conditions. The eye of the Chief Inspector cannot reach to every such installation, and one of the many deputies is sent to test the air conditions established. His records may show the legal degree of air purity, although he may well know that a test on the next day might show results which would doubly condemn the ventilating equipment. It is conceivable, therefore, that under these conditions the prime qualifications of a not too scrupulous tenant would be his desire to have selected for testing a favorable series of days and weather conditions.

4.—*BILL* 1008 *SUBJECTS FACTORY WORKER TO UNHEALTHFUL CONDITIONS.*

Its standard of approval makes possible on the part of the State Inspector the approval of conditions established by ventilators which ventilate only under certain weather conditions. What of other times?

5.—*BILL* 1008 *NULLIFIES EFFORTS OF TUBERCULOSIS CAMPAIGN.*

Pure air means health, the lack of it the spread of disease, particularly tuberculosis. This Society insists that no law be placed upon the Statute Books except it provide for and insure the furnishing of an ample amount of pure air at all times.

5.—*BILL* 1008 *RECOMMENDS A NEW, UNTRIED BASIS, DIFFERING FROM THAT IN ANY OTHER STATE LAW.*

This Society has before it copies of every ventilating law now in force in this country. They are all based on the measurement of *cubic foot of air introduced into the breathing space.* Should this State entirely depart from the practice which has proved thoroughly reliable and satisfactory in others, especially when that basis has been and is disapproved by all the engineers experienced in the art?

6.—*BILL* 1008 *PROVIDES A BASIS DIFFERING FROM THAT OF THE NEW YORK STATE SCHOOL VENTILATION LAW.*

This law reads: "No such plan shall be approved by him [the Commissioner of Education] unless provision is made therein for assuring ***at least*** 30 ***cubic feet of pure air, per minute, per pupil,*** and the provision for

exhausting the foul or vitiated air shall be *positive and independent of atmospheric changes.*"

The American Society of Heating and Ventilating Engineers offers the following substitute for the method of test and standard of ventilation provided in Bill 1008.

IN GENERAL.

Instead of approving a factory in respect to its ventilating equipment by measuring the amount of carbon dioxide present, let the standard be the constant and unvarying introduction of 1,000 cubic feet of pure air, per hour, per occupant, and 500 cubic feet of pure air per cubic foot of gas burned per hour. Let it also be required that the air shall be introduced without causing injurious drafts and without unduly lowering the temperature.

Determining the number of occupants is specified in the bill; the gas consumption can be obtained from the meter. The required amount of air is thus a matter of simple calculation and the fulfillment or non-fulfillment of the air volume requirements is then conveniently measured by an air meter, a simple device which measures the velocity of air issuing through the ventilating openings. The determination of the proper size of the ventilating equipment is made certain for the contractor by the stipulation of the definite number of cubic feet, and thus there is a minimum chance of annoyance to both owner and contractor through disapproval of equipment.

The supply of 1,000 cubic feet of air per hour per person is the minimum amount which will maintain the purity of 10 parts carbon dioxide in 10,000 parts of air, and 500 cubic feet of air per hour per cubic foot of gas burned per hour is the minimum amount which will maintain the purity of 15 parts carbon dioxide in 10,000 parts of air, and the standard is proposed as the only really practical standard, in being easy of measurement and in having proved acceptable for years to all identified with ventilation.

It is therefore urged that Bill 1008 be amended by striking out the parts in italics on lines 8 to 22, inclusive, on page 2, and the words "parts of carbon dioxide in ten thousand volumes of air," in line 23 on page 2 of the bill and substituting therefor the following: *All rooms or apartments of a factory having less than one thousand cubic feet of air space for each and every occupant and less than five hundred cubic feet of air space for every cubic foot of gas burned per hour, shall be provided with means of ventilation supplying constantly at least one thousand cubic feet of fresh air per hour for each and every occupant and at least five hundred cubic feet of fresh air per hour for every cubic foot of gas burned per hour. All rooms or apartments having one thousand cubic feet or more of air space for each and every occupant and five hundred cubic feet or more of air space for every cubic foot of gas burned per hour shall not be required to have artificial means of ventilation, provided the area of the exposed windows and doors is equal to one-eighth of the floor area of such rooms or apartments. Ventilation as hereinbefore prescribed shall be provided without causing injurious drafts and without unduly lowering the temperature in the workroom.*

New York, April 27, 1910.

(Signed by Committee.)

Mr. Hale: The suggestion may be made in reference to this fund which Mr. Macon wishes set aside for the assistance of the committee. It seems to me the Society should spend that. In Illinois several years ago we attempted to have a bill passed in the Legislature and the expenses were defrayed out of the chapter fund and none of the individual members of the Committee were compelled to contribute of their own funds to that work. It seems to me the Society should pay all the expenses of a committee of this sort.

The President: If there are no objections we will leave this over until miscellaneous business and then discuss the subject.

If there are no other committee reports, then we will have the communications from the chapters.

Mr. Weinshank: Mr. President, before you go to the report of the chapters, let us state to you the conditions in Indiana. The conditions in Indiana in reference to compulsory legislation are briefly described in the report of the committee, but I want to state the conditions as they exist to-day. We have all the powers at the State Capitol working on this law. The law was passed two years ago. It went through the Senate and the House, but for some reasons which have been explained a year ago by Dr. Hurty, the law failed to materialize.

Each State has a so-called medical society, and we in Indiana are working harmoniously with that society. The medical societies are powerful and influential, and are scattered throughout the State. In order to pass the law, we are now arranging to meet with the State society next October and have them appoint a similar committee as we have in the society, and together work before the Legislature. We have also with us the State Board of Health with Dr. Hurty, whom you all know, at its head. The city administration is offering its support. So taking those conditions into consideration, matters in Indiana look very rosy.

Next October when the State Medical Society meets again in session, we will have one of the members of the faculty of Purdue University read a paper before the Medical Society on the subject of ventilation with the intention of bringing up this matter for discussion and have them appoint a committee on compulsory legislation.

While the subject has been brought up by Mr. Macon with reference to our finances, I would suggest that it would be advisable to have a fund of $500 appropriated for different States. I do not believe there will be any funds necessary in Indiana as we have the wheels pretty well started, but it may be in other States funds will be required to have an attorney or have some one else draw up a bill.

Mr. Hale: It might be well at this time to call attention to this pamphlet which is about ready for distribution, being the printed report of the Committee on Compulsory Legislation and the Review Committee, which was made in January. The two combined will make one complete report.

In addition to what is given in this general report a member from the committee from Massachusetts, Mr. Whitten, states that they are working very strenuously at the present time to get proper action in that State. It seems that although there is a law in Massachusetts there is no one body or head to enforce the law. There is a Board of Health which has certain duties and also a Department of Police which conflicts with the work of the Board of Health, and as a result a member of our chapter from that State has gone to the Governor and has had a committee of five members appointed who will take up the question of legislation in the State of Massachusetts and bring it to a point where it can be enforced.

In Ohio an attempt is being made to bring the subject before the State Legislature, which does not convene until 1911.

In Michigan a bill has been prepared in co-operation with the State Board of Health and Mr. Still, who is a member of the committee, reports that he is very sanguine as to the outcome.

We have in prospect a bill for the next Legislature in Illinois which we hope will be put through in proper form. Wisconsin also is in line, and we understand that a bill is about to be prepared and presented in the State of North Dakota.

This is supplementary to the report that has already been made, and which will be handed out to the members.

Mr. Weinshank: At last winter's meeting I promised the Society that Dr. Hurty would write us a paper on the subject of the ill effects of poor ventilation. Unfortunately Dr. Hurty has been operated on for appendicitis about three or four months

ago, and he has been in poor health since; and yet to-day he called me up and asked me to express his regrets that he could not fulfill his promise and meet us here to-day. I therefore move that the Secretary be instructed to write Dr. Hurty a letter expressing our regret for his not being able to be with us and hoping that his health will be in such condition that he will be able to be with us next winter and help us to pass that law.

The motion was seconded and carried.

Mr. Macon: I do not suppose that this report of the committee of which Mr. Hale is chairman, on compulsory legislation, can be too highly commended. All of us who were present in New York can remember how highly it was applauded at that time. You will find in respect to the Utah laws that the last paragraph states that no schoolhouse shall hereafter be built with the furnaces or heating apparatus in the basement or immediately under such building. I immediately took up correspondence with the Utah people and evidently the subject has been under considerable discussion, as my original letter was sent in March and finally I got a long reply in the latter part of May. It appears the subject was taken up with the Secretary of the Governor of the State and his letter is as follows: (Reads.)

March 22, 1910.

MR. JOHN K. HARDY,
Sec'y to Governor Spry,
City.

My Dear John:—

You will remember furnishing the writer with a copy of the new school law providing for the heating of school buildings, and which is commented upon by the Metal Worker—a paper devoted to plumbing and steamfitting business, or in other words, sanitary measures in the school room as to plumbing and heating.

I am enclosing the letter in which they request the writer to discuss the question with reference to the installation of heating apparatus for school buildings. As I understand the new law, no heating apparatus can be placed in the basement or underneath the school building. By the adoption of this it positively eliminates the heating of school building by hot air furnaces, for the reason that hot air furnaces can only be used practically directly underneath the buildings, as pipes conveying hot air horizontally will not draw, and consequently the heat not reach the destination intended for it.

Do you know whether it was the intention of the Legislature, who passed this bill, to forbid the use of hot air or warm air heating in school buildings? The writer can readily understand that the law is a good one so far

as it applies to hot water or steam heating, but do not believe that the Legislature purposely intended to eliminate the use of heating by warm air.

If you can give me any further information as to the intent and purpose of this law in the direction mentioned, I will appreciate it, so that I may in turn furnish this information to the editor of The Metal Worker, of New York City. At your earliest convenience will be glad to hear from you, and also the return of the letter enclosed.

Yours respectfully,

T. A. WILLIAMS.

MR. JOHN K. HARDY, May 27, 1910.
Secretary to Governor,
City.

My Dear Sir:—

Beg to acknowledge receipt of yours of the 26th inst., together with copy of your letter to Dr. T. B. Beatty, Secretary of the State Board of Health, with reference to the inquiry made by Mr. W. W. Macon, editor of The Metal Worker, with regard to the law on the Utah Statute Books regarding heating of school houses, and note the resolution that was adopted at the meeting of the Commission, which practically settles the question regarding the heating of school houses within the State by what is known as the hot air method.

Wish to thank you for your kind attention to this matter.

Yours very truly,

T. A. WILLIAMS.

It was the result of that letter that they decided that they have got to follow the law strictly, which would mean that the warm air furnace could not be used properly unless a man could perhaps place a fan behind it and place it outside the building basement.

Mr. Hale: I move that the letters read be a part of the report and put in as extracts.

The motion was seconded, put to a vote and carried.

Mr. Lewis: At one of the meetings of the Illinois Chapter during the winter Dr. Evans, of Chicago, the Commissioner of Health, was present, and owing to remarks that he made, eventually a committee was appointed from the Illinois Chapter to meet with a committee composed of members of the Chicago Health Department and other gentlemen selected by Dr. Evans as a sort of commission to attempt to determine some of the points at issue regarding ventilation. Some things that came up were such as this: How much air should be furnished per capita in a theatre? How much in a factory? How much in a schoolhouse? This committee has been meeting generally twice a

month, and it is making a strong endeavor to arrive at conclusions on those points. We are attempting to get compulsory ventilation laws passed in different States. No two of them are alike. Some of them state that we must remove as much air as we put in. We ought to have a basis agreed upon by us as to what should be a standard, and how the air should be measured. This commission has been working along this line, and while we have no report to make as yet, I hope that eventually we will be able to formulate a set of rules or laws which can be agreed on with the Chicago Health Department.

The President: We will now call for the communications from the Chapters.

Mr. Hale: It is my understanding that the communications from the chapters should be made in January at the annual meeting. Consequently what few remarks I might make are without any preparation.

We are still meeting each month from October till May, and the attendance has been very good during this past winter. We have a membership of thirty-six in the city of Chicago, and from eighteen to twenty-five of those members meet each month to discuss subjects on heating and ventilation and listen to papers read by the members. We expect to have a complete report for the January meeting, giving the detailed report of each individual meeting that we have had during the last year.

The President: Are there any other communications? If not, the Secretary will call the next order of business.

Secretary Mackay: The next order is topic No. 1, "The Function of the Society and Its Achievements."

This topic was suggested by Mr. Frank K. Chew, a member of the Society, and he is unavoidably absent, and I understand that he has forwarded his remarks to Mr. Macon, who will read them.

The topic was read by Mr. Macon, and is in part as follows:

Mr. Chew: The Society has a membership of nearly 400, and yet the papers furnished for discussion and forming the basis of its valuable volumes of proceedings have been furnished by about 5 per cent., or one man in every twenty. There is a way to change this and make the Society of far greater value to each selfish member, and that is for that man to resolve

to contribute something that he knows. Be sure of the knowledge and that it is a fact. Long treatises are not essential. The work may not be ahead of the times. It may only be the true record of some common practice, but the data it affords will give it interest and value. It has been my pleasure to induce many who were preparing an article for the journal with which I am identified to make it a paper for this Society, and in one instance practically all of the papers read at one meeting emanated in the office or under the influence of that journal. I would say to every member the first duty on receiving notice of election as one of the Society is the selection of a subject and the beginning of the work of preparing a paper. Some papers have taken a year in the collating of the data. Some have been written offhand to supply a need.

Mr. May: It seems to me that the object of the Society of Engineers is, as Mr. Chew so aptly points out, to get engineering data; but it seems to me that one of the mistakes, if I may be allowed to make a friendly criticism of the work of this Society, has been the failure to differentiate between actual engineering devices which are of use in the profession and the asking of data and information from specific concerns which have bearing only on the products of that concern. I have in mind a discussion which came up with reference to safety valves. It was a discussion held by the Society of Mechanical Engineers. The question which they had up was "How much steam will a valve deliver?" They did not go into the fact of how large a spindle should be used or how large the disc should be. They wanted the manufacturer to tell them how much steam that valve would deliver. Now it seems, using the valve merely as an illustration, that this Society has been asking the size of the spindle rather than the main object of the valve. And it seems to me we ought to differentiate in the questions we take up in this Society as to what is actually used in the profession, in daily use, and cut out this trying to get hold of information which is the private property of some man and which, in itself, has no bearing on the success or the failure of the job; the manufacturer, if he has something special, will state and guarantee that his apparatus or this apparatus or special device will do such an amount of work.

Mr. Lewis: It seems to me that the greatest weakness of the papers that we now have is the lack of description of work that has actually been done. It seems to me that the most valuable things we can have are descriptions of plants installed, giving facts perhaps as to how the different sizes are determined and the actual operating results and costs. We must not degenerate into a crowd of people who come here to listen to the exploitation of a particular apparatus. It is a good thing for us to send strictly engineering information arrived at from our own experience. Many of our members could send very large, elaborate sketch plans and information about installations which would be of great value to the rest, and which would not injure the senders.

Mr. Morrin: Speaking of safety valves, and particularly about our own requirements, it has often occurred to me that the manufacturers of safety valves have overlooked the fact that the conditions for low-pressure valves are very materially different from those that operate against a higher pressure. I have in one or two instances improvised valves for low-pressure work that have given very excellent results. For instance, where a 1¼-inch valve would be allowable in area for the surface, I would substitute a 2-inch valve, and fitted the valve with a spring suitable to resist the pressure, the same working pressure that was required by the area of the 1¼. I found that the valve would operate very much more promptly, was much more sensitive and would operate with less noise. I was led to this suggestion by the difference we all recognize in the promptness and satisfactory working of two diaphragms, the difference between one 6 inches in diameter and one 12 inches in diameter. We know that we receive very much keener and prompter action from the larger diameter, and that also holds true with the safety valve. I think if attention to this suggestion was offered to the manufacturers of valves for low-pressure work, we would get more satisfactory results and the valves would close and close tight, and not partially close and sizzle for the time being, which is annoying in houses where steam is used for heating. We recently had a most interesting and determined discussion between the merits of steam and hot air in San Francisco for schools, and the superintendent of education was most

determined against the steam proposition. His contention was based on the fact that a leaking safety valve or a simmering safety valve had caused considerable nervousness on the part of teachers and scholars which could have been overcome by a properly proportioned safety valve.

Mr. James Mackay: This plea of Mr. Chew's is a timely one—requesting more papers for our meetings. As there was a dearth of papers it was finally suggested that we propound topics for discussion, and that has been done with more or less success. Then we have appointed committees to investigate certain matters of work kindred to our industry. But those committees have simply compiled individual opinions of members and non-members throughout the country as to the methods of doing certain kinds of work, and very few data of prime engineering value have been brought out.

Now with it all we are laboring under a dearth of papers, and with the number of meetings we have held and the experience of our members, we should be able to propound some plan whereby we can induce our membership to write papers and have them presented before this body. I suggested at one time that we commence a year and a half or two years ahead upon certain members, obtain their consent to write a paper, and have that paper in the hands of the Secretary months previous to the meeting at which it was to be used.

The President: With your permission I should like to change the regular order of business just temporarily.

Professor Kinealy: Mr. President, members and guests: You remember when it was decided that the meeting should be held in St. Louis you received an invitation sent by the Mayor of the City of St. Louis. The Mayor wished to be here and welcome you, and say to you a word of greeting, but unfortunately, being the head of a large city, there are many things that must demand and attract his attention, and he was unable to be here this morning; but he has sent one very worthy and able to represent him and the City of St. Louis. He has sent a gentleman who bears the official title of the Speaker of the St. Louis House of Delegates. I take pleasure in introducing to you Mr. Hugo Urbauer. Mr. Urbauer will say a few words of greeting to you.

Mr. Urbauer made an address welcoming the members and guests to the City of St. Louis.

On motion the session adjourned.

First Day—Afternoon Session.

(Thursday, June 30, 1910.)

The meeting was called to order at 2 P.M. by President Hoffman.

The President: The first thing on the programme is a paper on "Heating and Ventilation of Federal Buildings." In the absence of Mr. Thompson Mr. William H. Bryan, of St. Louis, will read the paper.

Mr. Bryan read the paper, which was discussed by Messrs. May, William M. Mackay, James H. Davis, Marvin, Weinshank, James Mackay, Kinealy and others.

The President: If there is no further discussion on this we will pass to the next order on the programme, topic for discussion, No. 3, "Appreciation of the Heating and Ventilation Engineer."

Mr. Morrin: Mr. President, I addressed a letter to the Secretary suggesting this subject for discussion. We on the Pacific Slope as heating and ventilating engineers are not appreciated, either by the owners or by the architects. We are made use of as a convenience, and sometimes as a necessity. I say this advisedly and from the point of some twenty-five years of experience on the Pacific Slope, where the necessity for heating and ventilating, while quite as important as in this climate, is not so absolutely necessary from the fact of our more favorable climate, with less difference in temperature extremes and less manufacturing, less smoke and foreign matter in the atmosphere and other things that tend to lessen the necessity of ventilation in particular.

It is only recently, while acting in a consulting capacity with a building committee in San Francisco, that the query was made by one of the members of the committee what was the necessity of employing a consulting engineer in the construction of their contemplated building. A commitee of two or three was appointed to learn what the custom was among architects and who should pay for his services. A prominent architect in San

Francisco advised this committee that it was not necessary to employ a consulting engineer on a building that involved the expenditure of $100,000 or less. The architect, however, who had been appointed, announced to the committee then and there that he did not care for the opinion of other architects, and that he presumed his position in the premises was positive and that he would employ an engineer, even if he had to do it at his own expense.

Mr. Davis: Mr. President, I think Mr. Morrin will find that we are going through a process of evolution in that respect, that is extending slowly from the east to the west. I look back over my experience in the heating business, about thirty-three years, to the time when there were only one or two consulting engineers in the whole United States, and now we have them in every large city, and they are all doing a very reasonable amount of business, an amount that I believe is increasing.

Now I know as a contractor that years ago I did not like to see an engineer on the job. I wanted to be the whole thing myself, and in that way have the favor of the architect. But I think we all recognize the fact that the heating engineer is here. He is here to stay. He has demonstrated his usefulness, not only to the owner and to the architect, but also as a protection to the contractor. And I believe that as every year goes by there will be more and more engineers employed on our large heating and ventilating jobs.

Speaking from the manufacturers' standpoint, I believe all the large manufacturers are anxious to see heating engineers employed wherever possible.

Mr. Bryan: We cannot expect other people to appreciate us until we appreciate ourselves, and to get that spirit, that point of view, we must make our work appreciated. We must stand always for the highest character of work; we must stand stronger against inferior grades of work, for the temptation always exists. The owner and the architect and the building committees with whom we work constantly look at the first cost. We must not let those conditions influence us beyond the proper degree. Stand for higher grades of work among ourselves; stand for higher grades of membership in the Society; more men and better men always. And remember, too, that before

we are engineers we are always good citizens, we are always citizens; let us always be good citizens. Let us take our share in all public movements in which a heating and ventilating engineer can be of benefit. But few engineers do that. Many of them, you might say almost all of them, are very modest. They are too generally inclined to take a back seat when public questions come up in which the influence and experience of the engineer can be made of the very greatest value. In respect to this see what the doctors are doing in these advance movements, the tuberculosis prevention scheme, and the excellent talk we had this morning as to the question of compulsory ventilation, not only the amount of air but primarily the quality of air and its distribution; this question of humidity. In all of this we can lead public sentiment. We can help advance legislation particularly along the line of better ventilation, as was discussed this morning. Give our endorsement to better and more correct ideas of professional standards. Take this research work that was discussed this morning, and as we continue in that sort of work and as we do things and accomplish results, then I think the heating and ventilating engineer will begin to be more and better appreciated.

Dr. Colbert: Undoubtedly a number of gentlemen present are suffering under the same sort of stigma that the general medical practitioner suffers under as the result of quackism. I can understand some of your troubles from my personal experience as a heating contractor, for I beg to inform you that for eight years past I have estimated on and designed steam, hot water and warm air furnace heating plants.

There are men in all the big cities of the United States, practicing as heating and ventilating engineers. They are designing or pretending to design and specify heating systems. They specify some specialty in which they have an interest; the architect accepts the plan, it is put up to the heating contractor and the heating contractor is expected to do the work exactly as specified, though he has no confidence in the specialties specified. In other words, he has no say about the designing of the job, but he is expected to guarantee it and stand financially responsible all the same. It is that class of men, I think, that cause the opposition to engineers throughout the contracting fra-

ternity, just the same as medical fakirs have caused opposition to the medical profession.

I know nothing about your present practice, but I believe if members of this society had a regular and recognized code of engineering ethics, similar to the code the medical profession has had to adopt, you would have but little trouble. At least the engineers who are known to be members of an organized body of Heating and Ventilating Engineers would have no trouble and would be fully appreciated.

Mr. Robert L. Gifford: This is a topic to which other engineering societies are giving considerable attention. For instance, the American Society of Civil Engineers, at their recent convention at Chicago, discussed the subject of legislation requiring or limiting the practice of civil engineering to persons holding a license from the State. On that line, in the State of Illinois a few years ago, when the architects' license law first went into effect, one who had been working as an architect and thus secured a license without any examination, was in a position to design the structural features of buildings, foundations, the structural frames, and so forth, possibly without knowledge or ability to figure strains; while at the same time a civil engineer or structural engineer who had been engaged in that particular class of work for years was unable to do that work in his own name. In the same way the architects largely overshadow the heating and ventilating engineer.

I think we should all unitedly controvert the idea that the architect and architecture cover and comprehend everything that enters into a building. The architect has the advantage, that is true. The public see his work; they see the beautiful elevation of the building. The heating and ventilation and other engineering features of the building are out of sight, and the old adage, "Out of sight out of mind," is certainly true in this case.

There might be a suggestion in that idea that it would only be fair to limit the design of heating and ventilating of important structures to engineers—heating and ventilating engineers who have been licensed by the State. Of course the fairest basis for such a system of licensing would be based probably

upon examination, possibly supported by examples of work actually constructed and in operation.

It is something that engineers in all lines of work are giving considerable thought to, getting proper recognition for their work, and as far as the contracting end of the business and the manufacturers are concerned, it certainly is to the interest of all to have the work laid out by competent consulting engineers. It insures fairness for the contractor. They all figure on the same definite set of plans and specifications. Under the present system it is almost impossible for owners to make a just and intelligent comparison of proposals.

The President: We will now pass to the next topic, No. 4, "The Science of Acoustics and Its Relation to Heating and Ventilation."

It was discussed by Messrs. Morrin, Kinealy, Macon, Hale, Weinshank and James H. Davis.

The meeting was then adjourned until Friday, July 1, at 10 A. M.

Second Day—Morning Session.

(Friday Morning, July 1, 1910.)

The meeting was called to order at 10 A. M. by President Hoffman.

The President: Taking up the programme, the Secretary will announce the first paper of the meeting.

Secretary Mackay: The first item on the programme for this morning is a paper, "Cast-Iron Hot Blast Heaters, New Methods in Testing and a New Mathematical Formula Used in Plotting Charts and in Figuring Results," by L. C. Soule, member of the Society.

The paper was presented and discussed.

The President: Mr. Whitten requests a committee to be appointed in Massachusetts to work with the Compulsory Legislation Committee. What is your wish in that regard?

Mr. Davis: I move that it be referred to the Board of Governors for action.

The motion was seconded and carried.

The Secretary read from a letter from R. C. Carpenter as follows:

The Committee on Standards, of which I am chairman for the present year, has in reality nothing before it for consideration that I can find out about. I propose to have the Committee suggest to the Society a line of desirable work for consideration in this field, at the annual meeting in 1911.

In my opinion the following subjects need consideration:

1.—Methods of rating and measuring radiators.

2.—Methods of testing house heating boilers.

3.—Methods of rating safety valves.

4.—Consideration of standard dimensions of various fittings, pipes, flanges, etc.

5.—Standard guarantees of heating apparatus.

6.—Coefficients for heat losses in buildings.

Mr. Macon: I move that the Committee on Standards be permitted to concentrate on the rating and measuring of surfaces of radiators and to devote as much time as possible to the question of standardization of flanges, fittings, steam pipes and return-mains.

The motion was seconded and carried.

The President: The next topic is No. 7, "The Air Washer as a Means for Humidifying the Air for Ventilation."

It was discussed by Messrs. Morrin, Zellweger, Kinealy and Weinshank.

The Secretary: Topic No. 8 is "The Desirability of Cast or Malleable Nipples in Radiators."

It was discussed by Mr. James Mackay.

Mr. Macon: The Committee on Legislation from New York State suggested the propriety of appropriating $250 for the work of such committee as might be appointed later. I therefore move that the subject of the appropriation of $250 for the work of promoting ventilation legislation in New York State be referred to the Board of Governors for action. (Seconded.)

Mr. Capron: I would like to make an amendment to that motion, that the same sum be appropriated for Illinois. Our Illinois Chapter have already spent $250, besides the work of the committee in trying to put through our bill, and if New York is entitled to an appropriation I think Illinois is.

Secretary Mackay: The work of the Compulsory Legislation Committee of this Society, in their endeavor to have a school ventilation law passed at Albany, in which they finally succeeded, and which the Society has the credit of, involved a total ex-

penditure to the Society of something like $137 expended at one session of the assembly. The cost of putting that law through the assembly, after seven or eight years of hard work, was in the neighborhood of $1,000, and it was all borne by the individual members of the committee, and no request was made on the Society for any payment.

Mr. Weinshank: I move, as a substitute for Mr. Macon's motion, that $500 be appropriated to be used by the Board of Governors at their discretion for the use of the propaganda of compulsory legislation. (Seconded.)

After some discussion the substitute motion was put to a vote and carried.

Mr. Weinshank: I will make a motion that this Society extend a vote of thanks to the members of the Local Arrangements Committee and the local administration for the manner in which they have handled the arrangements, for the manner in which they have entertained our members, and the manner and the way which they have handled the temperature of St. Louis during our visit, and I make my motion that a rising vote of thanks be given to the members of the St. Louis branch.

The motion was carried by a rising vote.

The President—The meeting stands adjourned.

List of Members and Guests present at the Semi-Annual Meeting, June 30 and July 1, 1910.

MEMBERS.

Armagnac, A. S.
Bradley, J. T.
Bryan, W. H.
Capron, E. F.
Cripps, A. G.
Davis, B. C.
Davis, J. H.
Donnelly, J. A.
Gates, H. T.
Gause, Bernard
Gifford, R. L.
Hale, J. F.
Harvey, Andrew
Hoffman, J. D.
Jewett, F. N.
Kauffman, Samuel
Kehm, August
Kirk, G. H.
Kinealy, J. H.
Lewis, S. R.
Mackay, James
Mackay, W. M.
Macon, W. W.
Marvin, M. J.
May, E. A.
Morrin, Thomas
Natkin, Benj.
Pittelkow, A. G.
Ritchie, Wm.
Shorb, W. A.
Soule, L. C.
Stannard, J. M.
Tait, Thos.
Weinshank, Theodore
Wade, J. R.

GUESTS.

Barry, Jas.
Bartlett, R.
Cash, A. M.
Chase, M. L.
Chouquette, C. H.
Colbert, W. F.
Collins, Emmons
Clark, F. V.
Clark, H. J.
DeLanney, A. H.
Dennis, J. F.
Dow, F. A.
Downe, G. E.
Dreckman, Otto, Jr.
Dubuque, A. A.
Elliott, Fred
Fitzgerald, J. J.
Fower, W. L.
Garven, W. A.
Haynes, W. J.
Hein, J. F.
Higdon, J. C.
Hurd, H. G.
Humphrey, H. H.
Landrigan, J. A.
Langenburg, E. B.
Leary, T. F.
Lodemann, C.
Lomasney, E. J.
Mackinnon, H. W.
Mehring, E.
Myer, M. L.
Neal, Howard
Parker, F. E.
Peters, T. K.
Phegley, P.
Rosenbaum, H. H.
Ross, J. B.
Ruebel, E.
Shelke, Lewis
Smith, C. M.
Smith, S. F.
Sparks, J. L.
Stern, Daniel
Stewart, N. B.
Tuttle, J. F.
Urbauer, H. F.
Whitelaw, H. S.
Wiemmer, Walter

Mrs. W. H. Bryan
Miss M. K. Bryan
Miss L. Newton
Miss V. Kinealy
Miss A. Weinshank

CCXXVIII.

HEATING AND VENTILATION OF FEDERAL BUILDINGS.

NELSON S. THOMPSON.
(Member of the Society.)

The practice of the office of the Supervising Architect of the Treasury Department in former years was to install gravity indirect steam or hot water systems in practically all the smaller buildings under its control, and where conditions precluded gravity indirect in said buildings direct-indirect was installed. In the large buildings mechanical ventilation supplemented with direct radiation was installed.

All office rooms in all buildings, both large and small, and all assembly rooms were provided with heat and vent flues, and the entire building except corridors was ventilated.

During this period no opportunity was afforded designers to inspect the work, especially the completed and occupied buildings, in which the care and operation of the systems in the buildings could be observed.

When this opportunity was granted it was discovered that the theoretical advantages of the system outlined above as applied to the smaller buildings were not secured in practice.

It was found in most instances that the fresh-air ducts and the base of the indirect radiator chambers were never cleaned, and in most cities there was so much soot and dust in the atmosphere that the walls around the registers were black. The air coming out of the registers had a bad odor and in general the system was not satisfactory.

It must be understood that this office does not have the power of selecting the engineers or firemen and has no direct control of them after their appointment.

The manner of supplying air to the direct-indirect radiators

was not satisfactory and that system fell into disfavor on that account.

During the period above noted the Federal buildings were of massive construction and the cost of the heating and ventilating apparatus in the smaller buildings did not bear a disproportionate relation as compared to the total cost of the building. In later years the massive masonry construction has been abandoned and much cheaper buildings are being erected, necessitating a reduction in the cost of the mechanical equipment. Contrary to the impression of the general public unlimited funds are not available for the erection and equipment of the buildings under the control of this office, and in the very large majority of buildings it is necessary to reduce the cost of the mechanical equipment to the lowest point and cut out all but the absolutely essential items.

In the buildings now being erected all the rooms have at least 1,800 cubic feet of space for each occupant, and in the large majority of the buildings electricity is used for illumination. Further, the area of the exposed windows and doors is in all buildings at least one-fourth the area of the floor.

Metal weather strips are not used in the smaller buildings. The main assembly room (post-office work-room) is frequently flushed out, due to the opening of exterior doors to admit and dispatch the mails.

In view of the foregoing it was decided to eliminate the ventilating apparatus in the smaller buildings not provided with court rooms. In practically all the smaller buildings the steel smoke stack is placed inside of a brick shaft and into this shaft openings, provided with top and bottom registers, are placed, which serve to draw air from the post-office workroom, the large basement toilet room and the room in the basement in which the letter carriers remain when off duty.

The small private toilet rooms are used infrequently and being provided with generous exterior windows no vent flues are installed for them.

When the building contains a court room, gravity indirect radiation is installed for the court room sufficient to change the air in the room not less than twice an hour and a vent flue or flues are installed and connected with the vent shaft.

The heating of the court room is done by direct radiation and the indirect radiation merely heats the air to 75 degrees F.

Where conditions preclude the installation of a gravity indirect stack for the court room, direct-indirect radiators are installed to supply ventilation, and the vent flues as above noted are installed also.

In the large buildings all the heating is done by direct radiation and the fresh air is admitted to the rooms to be ventilated at about 75 degrees F. The ventilation in the large buildings is confined mainly to the post-office work-rooms, court rooms, rooms in which a number of people assemble and the principal office rooms.

The advantages of this system are that the ventilating apparatus may be shut down from, say 6 P. M. to 8 A. M., and the direct radiation kept in service continuously in order to prevent the building cooling off. An accident to the fan motor does not cripple the entire heating and ventilating system as is the case with the straight hot blast system.

In the larger buildings the post-office section is in operation night and day continuously, with no shut down, and it is imperative that sufficient heat be supplied at all times when needed.

In several of the large buildings the vent flues from the office rooms were omitted and the fresh air forced in by the fan sought an outlet through crevices around entrance doors into the corridors, or escaped mainly through the crevices around the windows.

The practice now is to install metal weather strips in all buildings provided with mechanical ventilation and wherever the construction permits to install vent flues from the apartments supplied with fresh air.

Even with metal weather strips, when air is admitted for ventilation only, it is not deemed necessary to install vent flues in each office room; the vent flues or registers provided in the assembly rooms and main toilet rooms are ample to carry off all the air forced in by the fan.

Vent registers installed in entrance doors from corridors are regarded as being useless and unsightly.

In all buildings equipped with a plenum fan the practice is

to install an air washer, as such devices are looked upon as the most essential feature of a successful ventilating apparatus. Many of the old ventilating apparatuses were a failure on account of the inability of the dry-air filter to cleanse the air properly.

When funds are available a first-class automatic temperature-controlling apparatus is installed in the larger buildings.

Aside from the comfort assured by a first-class automatic temperature-controlling apparatus, a saving of not less than 10 per cent. in the coal pile is secured.

No apparatus is complete without some means of absolutely and automatically controlling the temperature of the apartments.

The vapor systems of steam heating, as applied to small Federal buildings, where operating conditions are somewhat different from commercial practice, have not given very satisfactory service and our practice is tending away from these.

The simple one-pipe gravity return steam-heating system operating at atmospheric pressure, such as installed by this office, has given us the best service.

The argument advanced in favor of temperature control in the vapor systems carries very little weight in the selection of the system for these small Federal buildings.

In large buildings, where an electric generating plant is to be installed, the practice of the office is to install a vacuum system with a pump or injector. These devices are a valuable and economical adjunct to such a plant.

The experience of the office has demonstrated that steam-heating is the most satisfactory system and it is always installed, except in localities where the lowest recorded temperature is plus ten or above, or where a district heating system exists which employs hot water as the heating medium. It has been demonstrated that the advantages of hot-water heating are almost purely theoretical and the advantages, except under intelligent operation, are not secured in practice. The foregoing statement must not be construed as applying to any other than Federal buildings.

This office endeavors to secure a certain amount of temperature control in connection with its small steam-heating

systems by installing in all apartments with two or more outside windows at least two radiators of equal size, so that in mild weather one may be entirely shut off and remain out of service.

This is recognized as a makeshift, but is the best possible solution with the limited funds available.

Whenever a district-heating system is in operation in a city in which a Federal building is to be erected or remodeled, the heating apparatus is so designed that it may be operated from the district-heating system or from boilers installed in the building. The boilers are always installed in the building to serve as a check on the cost of outside service and for use in case of a breakdown in the district system.

It is generally more satisfactory and economical to purchase steam or water for heating the building than to generate it in the boilers provided.

The practice of the office is to ascertain the amount of radiation required by the B. T. U. method and the results are checked by the experience and judgment of the engineer in charge.

BASIS FOR CALCULATING RADIATING SURFACE.

The lowest temperature on record in the locality is ascertained from the Weather Bureau reports, and if the city has no station then the nearest station to said city is taken.

In southern cities, where the lowest recorded temperature occurs only occasionally, and then only for a day or two during each season, the calculation is based on a temperature 10 degrees in excess of lowest on record for the last ten years.

In northern cities, where temperature goes below minus ten degrees, the calculation is based on the lowest temperature recorded during the last ten years.

All office rooms, post-office work-room, court rooms, corridors, lobbies, carriers' swing room and toilet rooms containing bathing facilities, are heated to 70 degrees. The amount of heat to be supplied to the general toilet rooms, where no bathing facilities are provided, is reduced to a minimum and the room is never heated above 60 degrees. In southern latitudes, where the calculation is based on plus ten or above,

no heat is placed in any toilet room, except carriers' toilet room. Small toilet rooms, which open off of office rooms, are not heated, where lowest on record is zero, or above.

After determining the temperature upon which the calculation is to be based, the heat losses are ascertained by the B.T.U. method, using the following coefficients for glass and wall, etc.:

HEAT TRANSMISSION PER DEGREE DIFFERENCE IN TEMPERATURE BETWEEN INSIDE AND OUTSIDE AIR.

	Solid Brick Wall. (One wall exposed.)	Solid Brick Wall. (Two walls exposed.)
12"	.265	.232
18"	.210	.185
21"	.187	.165
24"	.167	.150
27"	.152	.140
30"	.140	.130
33"	.130	.120
36"	.120	.113
40"	.112	.103

	Hollow Brick Wall. (One wall exposed.)	Hollow Brick Wall. (Two walls exposed.)
12"	.220	.170
18"	.175	.137
21"	.160	.125
24"	.147	.115
27"	.135	.105
30"	.125	.097
33"	.117	.090
36"	.110	.084
40"	.100	.077

	Solid Granite or Marble Wall. (One wall exposed.)	Solid Granite or Marble Wall. (Two walls exposed.)
12"	.400	.335
18"	.340	.290
21"	.315	.275
24"	.295	.260
27"	.280	.245
30"	.265	.232
33"	.250	.220
36"	.235	.210
40"	.220	.200

	Hollow Granite or Marble Wall.	Hollow Granite or Marble Wall.
12"	.305	.245
18"	.270	.215
21"	.255	.202
24"	.240	.190
27"	.228	.180
30"	.218	.172
33"	.208	.164
36"	.200	.157
40"	.190	.149

Brick Walls with Sandstone Faces. Plastered on the inside.

Brickwork.	Thickness of Sandstone Face. 4"	8"	12"
4"	.31	.29	.26
8"	.22	.20	.19
12"	.17	.16	.15

	Concrete or Sandstone.	Limestone.
12"	.45	.49
16"	.39	.43
20"	.35	.38
24"	.31	.35
28"	.28	.31
32"	.26	.28
36"	.24	.26
40"	.22	.24

Single flooring (as a ceiling). Unheated room above heated room	0.10
Double flooring (as a ceiling). Unheated room above heated room	0.09
Ordinary lath and plaster ceiling	0.32
Fireproof floor (as a ceiling)	0.20
Outside walls of frame buildings, lath and plaster inside, outside construction as below:	
Ordinary over-lapping clapboards 7-16"	0.44
Same with paper lining	0.31
Same with 3-4" sheathing	0.28
Same with 3-4" sheathing and paper	0.23
Assume temperature of attic of buildings as 30 degrees above lowest outside temperature.	
Glass in single windows	1.020
Glass in double windows	0.472
Glass in single skylight	1.090
Glass in double skylight	0.492
Assume exterior doors same as glass.	

In rooms over 12 feet high the heat loss is increased by an amount due to the rise in the mean internal temperature, and by the increased rate of air movement over the interior surface of the wall. This increase is practically 2 per cent. for each foot of ceiling height over 12 feet.

The tables are for southern exposure and the maximum allowance which should be made for other exposures, should be as follows:

North	35%
West	25%
East	15%

To this add the following for loss due to leakage:

35 per cent. for office rooms.

65-100 per cent. for main lobby, work room and court room depending on size of room and its use.

Allow for direct steam radiation, standard 3-column 38-inch high radiator, 250 B.T.U. and for water 170 B.T.U. per square foot per hour. For commercial practice, where the conditions are not the same as in Federal buildings, the divisor for steam heating should be 280 and for hot water 190 in lieu of 250 and 170 above stated.

If a direct radiator is enclosed in a window breast with a proper arrangement for circulating air over it, 200 B. T. U. for steam and 120 B. T. U. for water are allowed. 3 square inches net area in registers or grills is allowed to concealed radiators per square foot of surface.

DIRECT-INDIRECT RADIATION.

For direct-indirect heating a speed of five feet per second through the cold-air inlet duct to the radiator is assumed to ascertain the amount of air which must be raised from ex-

terior temperature to that of the room. This speed has been observed in several anemometer tests of these systems.

The heat losses through wall and glass are ascertained by using the exposure factor the same as in direct radiation, but in lieu of using leakage factors the number of B.T.U. required to raise the temperature of air introduced through the radiator from the lowest recorded to room temperature is ascertained. 300 B. T. U. per square foot for steam flue radiators and 200 for hot water are allowed. In selecting the boiler the direct-indirect is reduced to direct equivalent by adding 20 per cent. to the actual direct-indirect radiation installed.

Vent flues, with a positive outflow, such as is created by a fan, or an aspirating coil, are provided to assist inflow of air through the direct-indirect radiators. A speed of three feet per second in the vent flue connected into a good roof ventilator properly located is allowed.

This system is sometimes used with hot-water heating apparatus, but its use is not desirable where the lowest on record is below plus five.

GRAVITY INDIRECT RADIATION.

The office practice is to assume that the temperature of entering air under extreme outside conditions will be 120 degrees F. for steam and 100 degrees F. for hot water.

The amount of radiation to install is ascertained by the B. T. U. method, taking into account the heat losses through wall, glass and ceiling, and making allowance for exposure, and in addition, allowing ten per cent. for loss of hot air through window cracks. The B. T. U. ascertained as above and multiplied by 55 and divided by 50 for steam and by 30 for water will give the number of cubic feet of air which must be admitted to the apartment per hour to heat it.

The number of B. T. U. required to raise the temperature of the air from the lowest outside temperature to 120 degrees for steam and 100 degrees for water plus 5 degrees (allowance for temperature drop in flue) is ascertained and the resulting number of B. T. U. is divided by 350 for steam indirect, natural draft, and 220 for hot-water indirect, natural draft.

The size of hot-air flues and ducts to be installed is ascertained by assuming the following speeds:

Air speed to first floor 200 feet per minute.

Air speed to second floor 300 feet per minute.

Air speed to third floor 400 feet per minute.

The vent flues and cold-air ducts are made the same size as hot-air flues.

In climates 10 degrees F. and below, the 12-inch or 15-inch deep extended pin radiators are used for steam and in all climates similar radiators are used for water. For climates where temperature is below ten degrees F., two 12-inch deep radiators for hot water are used.

The allowable speed through cast-iron pin indirect radiators for natural draft is limited to approximately 2 feet per second through one section deep. High speeds necessitate the placing of one section on top of another with a space of about 4 inches between the sections. Five feet per second through the radiator is the limit with natural draft.

The checks rule for indirect flues when the room is to be heated by hot air is to make their area in square inches equal to the area of glass in square feet plus one-fourth area of exposed wall in square feet. No flue to be wider than three times its depth.

None of the cast-iron indirect radiators contain the amount of surface claimed for them in the manufacturers' catalogs, and to be conservative 20 per cent. of the amount claimed should be deducted in laying out and installing them. The foregoing statement does not apply to the special type of hot blast cast iron indirects now in use.

DIMENSIONS OF PIPING.

One Pipe Steam Mains for Runs up to 200 Feet in Length.

Size of Flow Pipe.	Direct Radiation.	Dry Returns.	Wet Returns.
1"	40	¾"	¾"
1¼"	75	1"	¾"
1½"	126	1"	1"
2"	286	1¼"	1"
2½"	535	1½"	1"
3"	890	1½"	1"
3½"	1360	2"	1"
4"	1950	2"	1"
5"	3600	2½"	1¼"
6"	5900	3"	1½"
8"	12700	4"	2"
10"	22900	5"	2½"
12"	37000	6"	3"

For other length of runs see formula given with the two-pipe schedule. In patent steel steam boilers two tappings are used of such size as to keep the velocity of steam in the verticals down to not over 20 feet per second.

ONE PIPE STEAM DIRECT RADIATOR TAPPINGS, ARMS AND RISERS.

Sq. Ft.	Tapping.	Riser and Arm in Basement and Radiator Arm.
0—20	1"	1"
21—24	1"	1¼"
25—40	1¼"	1¼"
41—60	1¼"	1½"
61—80	1½"	1½"
81—100	1½"	2"
101—200	2"	2"

TWO PIPE BASEMENT MAINS, GRAVITY CIRCULATION, DIRECT HOT WATER RADIATOR TAPPINGS

First Floor.	Second Floor.	Third Floor.	Fourth Floor.	Pipe Size.
40	50	60	70	¾"
70	80	90	100	1"
110	120	135	150	1¼"
180	195	210	230	1½"
300	350	400	500	2"

At ends of mains increase tapping one size.

No main to be less than 1¼ inches.

To get the size of mains and risers serving more than one radiator, add areas of tappings together and use the following equalizing table:

TABLE OF EQUALIZING PIPES.

½"	equals	2
¾"	"	5
1"	"	10
1¼"	"	20
1½"	"	30
2"	"	60
2½"	"	110
3"	"	175
3½"	"	260
4"	"	380
5"	"	650
6"	"	1050
7"	"	1600
8"	"	2250

If you have a ¾-inch pipe and a 1-inch pipe, to get the size pipe to serve them—¾-inch equals 5; 1-inch equals 10; 15 equals 1¼ inches.

TWO-PIPE GRAVITY DOWN-FEED HOT-WATER PIPING.

(Flow main in attic and return in basement.)

Radiator tappings, same on all floors, are as follows:

0— 50, ¾" flow and ¾" return.
51—100, 1" flow and 1" return.
101—200, 1¼" flow and 1¼" return.

The sizes of mains and risers serving more than one radiator are ascertained by adding the areas of tappings and using the equalizing table before given. In this connection the main riser pipe from boiler to attic may be greatly reduced in size

if a proper chamber or expansion tank is placed at the top of the main riser.

The size of main riser may be taken from the following table:

1½",	300	sq. feet direct radiation.
2"	600	" " "
2½",	1200	" " "
3",	2000	" " "
3½",	2500	" " "
4",	3500	" " "
5",	6000	" " "
6",	10000	" " "

ONE-PIPE CIRCUIT HOT WATER.

The same tapping and risers as given for two-pipe hot water are used.

To arrive at the size of one-pipe circuit hot-water mains the following sizes are used:

	200′ Runs.	300′ Runs.
2"	200	180
2½"	400	300
3"	600	500
3½"	900	700
4"	1200	1000
5"	2300	1800
6"	3600	3000
7"	5200	4000
8"	6800	6000

A 1-inch or 1¼-inch starting pipe is used with this system.

The lengths of mains are measured back to the boiler.

Tees on the main are kept two feet apart. Risers are taken out of the main on 45 degrees and first floor connections out of top of the main. All returns are taken into the side of the main. No special fittings are used, except twin ells on mains where they branch.

TABLE FOR MAINS, RISERS AND TAPPINGS FOR TWO-PIPE STEAM HEATING SYSTEM.

For two-pounds and five-pounds steam pressure.

Diameter of Supply in Inches.	Diameter of Return in Inches.	2 lbs. Pressure Total Heat Transmitted in B. T. U. per Hour.	Radiating Surface in Sq. Ft.	5 lbs. Pressure Total Heat Transmitted in B. T. U. per Hour.	Radiating Surface Sq. Ft.
¾	¾	5,000	20	10,000	40
1	¾	9,000	36	15,000	60
1¼	1	18,000	72	30,000	120
1½	1¼	30,000	120	50,000	200
2	1½	70,000	280	120,000	480
2½	2	132,000	529	220,000	880
3	2½	225,000	900	375,000	1,500
3½	2½	330,000	1320	550,000	2,200
4	3	480,000	1920	800,000	3,200
4½	3	690,000	2760	1,150,000	4,600
5	3½	930,000	3720	1,550,000	6,200
6	3½	1,500,000	6000	2,500,000	10,000
7	4	2,250,000	9000	3,750,000	15,000
8	4	3,200,000	12800	5,400,000	21,600
9	4½	4,450,000	17800	7,500,000	30,000
10	5	5,800,000	23200	9,750,000	39,000
12	6	9,250,000	31000	15,500,000	62,000
14	7	13,500,000	54000	23,000,000	92,000
16	8	19,000,000	76000	32,500,000	130,000

A radiator assumed to transmit 250 heat units per square foot per hour. The above table is for pipes 200 feet in length. For pipes of greater length, multiply the results in table by $\frac{200}{e}$ in which e equals length in feet. The values of this expression for different lengths of pipe are: For 300 feet, multiply radiation in table by 0.66 2-3; for 400 feet, by 0.50; for 500 feet, by 0.4; for 600 feet, by 0.33; for 800 feet, by 0.25; for 1,000, by 0.2.

CAST IRON BOILERS.

The experience of this office has been such as to lead us away from the use of cast iron sectional boilers, steel boilers being preferred. When conditions dictate the use of cast iron boilers their size is ascertained by adding to the actual direct radiation installed 25 per cent. for mains, if anthracite coal is used, and 35 per cent. if soft coal is used, and *two* boilers are installed, each rated to carry two-thirds of the result obtained above. One boiler will then, if forced, carry the radiation for a few days in case of a breakdown in one boiler.

To obtain the size of the stack when cast iron sectional boilers are used, the formula is:

$$\text{Area in square feet} = \frac{\text{Area of grate in square feet x 0.75}}{\sqrt{\text{height of stack}}\text{ in feet.}}$$

The tappings for steam connections to the boilers are made not less than two in number and their combined area must be such that the velocity of steam is not over 12 feet per second in the verticals.

Returns are connected into both sides of each cast iron boiler.

A 2-inch equalizing pipe from the bottom of the main header into the main return header is always installed on all vertical steel or cast iron boilers.

STEEL BOILERS.

In Federal buildings of small size, in which a down-draft furnace is not to be used, consideration is given the installation of a round, vertical steel boiler. The maximum size for this type of boiler is one with 28-inch diameter grate.

A down-draft furnace is not attached, even when bituminous coal is the cheapest fuel, until the size of boiler required is such as will serve 2,600 square feet of direct steam radiation. The down-draft furnaces are installed to comply with the local smoke ordinances which exist in many cities and towns.

Where small-size anthracite coal is the cheapest fuel, the boiler and grates are installed to use that fuel, and the maximum openings in the grate bars are specified not to exceed 3/8 inch. The size of boiler to be used, when small anthracite coal is the cheapest fuel, is obtained by adding 50 per cent. to actual direct radiation installed.

When the cost of 20,000 cubic feet of natural gas is cheaper than one ton of the cheapest coal, the boiler is equipped with burners, pilot light and governor. The boiler rating for use with gas is ascertained by adding 25 per cent. to actual direct radiation installed.

When bituminous coal is the cheapest fuel, 35 per cent. is added to the actual amount of direct radiation installed to get the boiler rating, and no allowance is made for additional heating surface in the water-tube grates of down-draft furnaces.

When three times cost of oil per barrel plus the cost of seven kilowatt hours of electric current per day (generally 70 cents), is less than cost of one ton of the cheapest coal, oil is used as a fuel, and the boiler is equipped with oil burners, pump, tanks, etc.

The size of boiler for use with oil is ascertained by adding 25 per cent. to the actual direct radiation installed.

When the catalog rating of the vertical steel boiler required exceeds 3,000 square feet, the advisability of installing either two small, portable steel boilers, a 3600-foot portable steel boiler, or a horizontal return tubular boiler, is considered.

All the ratings given above are direct steam ratings and the remarks apply to hot-water boilers of equivalent capacities.

Where a horizontal return tubular brick-set boiler is to be installed the same is proportioned as follows:

R = total direct radiation in building square feet.

B.H.S. = heating surface in boiler in square feet.

G = area of grate in square feet.

B.H.S. = R/7 for steam; R/11 for water.

G = B.H.S./25 for anthracite, pea or rice, and B.H.S./30 for nut anthracite.

G = B.H.S./30 to 35 for bituminous coal.

G = B.H.S. /45 for lower grate of down-draft furnace.

H = height of stack in feet.

A = area of grate in square feet.

S = area of stack in square feet.

$S = \frac{A}{\sqrt{H}}$ for anthracite lump coal, oil and gas.

$S = \frac{A}{\sqrt{H}} \times 1.25$ for bituminous and small anthracite.

For anthracite, pea or rice coal, the tube area must be not less than one-eighth grate area, and always larger than stack area.

For boilers with down-draft furnace attached the tube area must be not less than one-sixth area of the lower grate and always larger than the stack area.

Maximum length of tube must not exceed 48 diameters.

Maximum length of boilers, 54-inch diameter and under, 3 diameters, over 54-inch, 2½ diameters. Tubes, an odd number of feet long, are not used.

Coal consumption for low-pressure heating apparatus in tons per heating season will be found as follows in Government buildings:

Area of grate or grates in square feet by 5 equals tons of coal burned per heating season of 240 days.

Safe rule is that for each cubic foot of contents of building one pound of coal will be required to heat building for heating season of 240 days.

To find size of coal storage room for a Government building, allow 8 square feet of floor space per ton of coal, and it is arranged to store the entire season's supply in the small buildings.

To ascertain boiler horse-power for heating of a building in New York City, or a similar climate, allow 100 boiler horse-power for each 1,000,000 cubic feet of contents for zero weather, and in average winter weather two-thirds of this will be the horse-power required. Between 40 and 50 per cent. of

maximum will be the boiler horse-power required for the full heating season of 5,700 hours. An excellent rule is to assume that each square foot of radiating surface in the building, direct and indirect, will require 1,000,000 B.T.U. per season of 240 days.

WATER-TUBE BOILERS.

In all buildings where steam is to be used for power purposes, or is likely to be so used at some future time, water-tube boilers are installed.

The minimum size of water-tube boiler installed is 100 horse power. All water-tube boilers are rated at 10 square feet of heating surface per horse power. The clear height from bottom of firing pit to under side of ceiling beams must be not less than:

For boilers 150 horse-power and smaller	14′ 6″
" 150–175 horse-power	15′ 0″
" 175–200 "	15′ 6″

It is not deemed advisable to publish in this paper the basic data used in proportioning the mechanical ventilating apparatus for the large buildings other than to say that the formula of Professor Kinealy is used to determine size of fans and horse power of motors to operate same; that the speed through air washer is limited to 400 feet per minute of net area; that the speed through the blast coils is generally limited to 1,000 feet per minute, and that the main plenum duct speeds are limited to 1,800 feet per minute, and the use of volume dampers obviated by contracting the connections from main ducts to the upcast flues, an amount which is based on the calculated pressure which will exist and be maintained at that point, when fan is running at maximum determined speed.

The design of the above systems is in process of revision, and when the final data are worked out, a paper stating the basic data will be submitted to the Society.

The office feels the need for definite information on the subject of ventilation, and has taken steps to detail a trained employee to visit completed and occupied buildings and make anemometer tests of the ventilating apparatus and determine the purity of the air in the ventilated and unventilated buildings.

Only a small number of buildings have been visited so far,

but when the conditions permit the investigations will be continued and some absolute facts will be learned and used as a basis to govern future designs of heating and ventilating apparatus.

All heating and ventilating apparatus, after being designed, must have their cost of installation approximated by the office, in order to check the proposals received; the department has prepared data to approximate the cost, which have proved accurate within 10 per cent. when compared with the proposals received.

APPROXIMATE COST OF HEATING APPARATUS PREPARED FOR THE PURPOSE OF CHECKING ESTIMATES.

Boiler, vertical steel.........................Take 50 per cent. off price list	
Labor to install, trim and test vertical steel boiler....................	$50.00
Down-draft furnace (Hawley), in place...........................	600.00
Foundation brickwork for boiler, per 1,000, in place................	20.00
Foundation concrete for boiler, per cu. yd., in place..................	8.00
Stone coping and steps for boiler pit, per cu. ft., in place............	4.00
Breeching and stack (8c. per lb., in place).	
Cast iron base plate for stack (3c. per lb., in place).	
Radiators, average 20c. per sq. ft., in place (not connected).	
Painting and bronzing, 3c. per sq. ft. radiation.	
Radiator valves and air valves (steam), per radiator.................	3.50
Radiator valves and air valves (water), per radiator...............	4.50
Air valves at ends of mains, in place, each..........................	.50
Standard gate valves on mains, 50 per cent. of list price, in place.	
Labor, one pipe steam jobs, per radiator............................	6.50
Labor, two-pipe, hot-water jobs, per radiator........................	8.00
Freight and drayage, 3 per cent. of cost of boiler, furnace, radiation, pipe and fittings.	
Superintendent, 1 per cent. cost of all labor and material.	
Non-conducting covering (pipe, boiler and breeching, in place), take at 10c. per sq. ft. of direct radiation.	
Pipe and fittings, one-pipe steam, per radiator......................	7.00
Pipe and fittings, two-pipe hot water, per radiator..................	10.00
8-in. wide return-pipe trench, cast iron cover, per lin. ft., in place....	1.50
Blow-off pot (18 in. x 24 in.), in place, complete, with all pipe and valves	50.00
Expansion tank (40 gal.), in place, complete with piping...........	25.00
Thermometers in place, each......................................	1.00
Hot-water damper regulator (Sylphon type), in place, each..........	20.00
Board on out-of-town jobs, per radiator............................	2.00
Railroad fare can be readily ascertained when the distance the job is from headquarters is known. Assume for Federal buildings that it will average 300 miles and take railroad fare at................	50.00
Profit, per cent..	20

DISCUSSION.

Mr. May: Regarding the abandonment by the Government of cast-iron boilers, it is not because they deem them overrated. The actual fact is that the Government believes that the cost of repairs on cast-iron boilers is excessive, and for that reason only I believe the Government has abandoned the use of cast-iron boilers as a general practice. The practice started with the War Department, although this paper refers particularly to the Treasury Department. It was found after investigation that the running of boilers was under the care of soldiers who were temporarily under a cloud and who were occupants of the guard-house. Of course, under those conditions a new fireman came in every two or three days. So that I believe it is purely a question of the cost of repairs. They have had excellent satisfaction with the rating of cast-iron boilers.

Secretary Mackay: The paper gives us an interesting idea of the Government method of selecting heating apparatus for buildings. There are one or two points that I have found out in my practice. For instance, there is a statement, "It has been demonstrated that the advantages of hot-water heating are almost purely theoretical, and the advantages, except under intelligent operation, are not secured in practice." My experience has been exactly the opposite of that. I find that you can neglect a hot-water apparatus and get results from it, while sometimes other apparatus do not give results with the best of attention; and the larger and more exposed the building the better results I have obtained. And the economy of fuel which I have found in many cases where steam or hot air apparatus has been replaced with hot water is that the same building has been heated more satisfactorily and more economically.

In connection with cast-iron boilers, I have known for years that the Treasury Department and also other departments of the Government were in favor of wrought iron construction. I have always thought that it was because they considered it was better or something of that sort. But I did not know that it was because they had not got good results from cast-iron boilers. I know many cases in Government buildings where the accepted type of vertical wrought iron or steel boiler has rotted

out through non-use in the summer time, and has been replaced with cast-iron sectional boilers with good results. I also know many cases in large buildings where they have replaced horizontal tubular boilers with sectional cast-iron boilers, giving better results with greater durability and economy.

The greatest objection, in my mind, against the steel tubular boiler used for heating, is that at the time you are not using it, it goes to pieces. I have in my office a piece of wrought iron not any thicker than a piece of paper taken from a tubular boiler that was used in a church building. The apparatus was only used from Friday night until Sunday night, and it was not fired during the week. In eight years the boiler went from a quarter of an inch to not any thicker than paper.

I was called on some twenty years ago to design a hot-water heating apparatus for a county building in New York State. They were in favor of a wrought-iron boiler, and while my early experience was that wrought iron was the only thing to use (I had to change over to cast iron before I got to be a cast-iron boiler man) I advised them that it was a mistake to put wrought iron in there. While I said it would not last ten years the manufacturer said, "We have lots of them running twenty to twenty-five years, some of them even thirty years, without any repairs." I put myself on record, and after my protest they put it in. In eight years they spent $500 for repairs on the steel boiler and in nine years they took it out and replaced it with cast-iron sectional boilers. That is eighteen or twenty years ago, and those cast-iron boilers are still doing excellent work. The cast-iron sectional boiler used for heating actually stands more than double the life of the steel boiler. My experience with the steel boiler is that it goes to pieces, and I have had many demonstrations of that fact.

Mr. May: In one place the author speaks about a larger sized boiler being required if oil is used. Mr. Bryan says that is so. I would like to have Mr. Davis, of Kansas City—I think he has had some experience with an oil-burning system—tell us something about it.

Mr. Davis: We find in working all over our territory that we get a much higher efficiency out of boilers where we have oil as a fuel than we do where we have coal.

Mr. Donnelly: How about capacity?

Mr. Davis: Well, the same boiler will take care of a great deal more radiation with oil than with coal, both in direct steam installation and blast steam installation. In some tests that we made the boiler showed, I think, about 25 per cent. to 33 per cent. greater evaporation with oil than with coal, although I have not the data with me. I quote the figures offhand.

Mr. Morrin: I think the last speaker's results are quite correct in the use of oil as a fuel. In California we can get 25 to 50 per cent. more efficiency from the same heating surface with the use of oil burning than we can with coal fuel, either bituminous or anthracite. We can also operate a water plant with a fuel capacity the same and some 35 or 40 per cent. less water heating surface than we can with coal. It is our custom there, in installing chimneys for oil fuel only, to use about 60 or 65 per cent. of the area that we have been in the habit of using for coal.

The anthracite we use on the Pacific Slope is mostly Welsh imported coal. It is very excellent coal, very high in heat units, very low in ash. With that coal we reduce the grate so that the air space may not be too great. The softest coal, the less efficient coal, requires more grate surface than the anthracite.

The type of burner used for oil is a living problem in the use of oil, a well-diffused fire being much more efficient than a less diffused fire and higher temperature.

Secretary Mackay: I have seen a number of Government hot-water heating apparatus in place and have seen specifications of them where, in my judgment, the application is wrong and expensive. The return line, instead of being carried on the basement ceiling, providing there is no basement radiation, is carried down below the basement floor back to the boiler. My experience and judgment is that that is a wrong application of hot-water heating, and is bound to work against the system; that if your return main is placed on the ceiling you will have the benefit of it; whereas if you place it below the boiler you will have to force the water back to the boiler, and there is not only the increased expense of putting it down there in trenches, but a poorer operation of the apparatus.

I know two buildings in New York City, not Government

buildings, that were placed in that way, and they were unsatisfactory. No change was made in either the boilers, radiators or flow mains, the return mains in the basement were taken out of the trenches and put on the ceiling, falling to the boilers, and the apparatus has been working very satisfactorily for a number of years.

In my earlier work I had a case where there were some basement returns, and I conceived the idea of connecting the returns from the upper stories with the basement radiation, and I found it interfered with the whole radiation, and while the basement radiation had to have the return under the floor, the returns from the upper stories were placed on the basement ceiling and gave good satisfaction. I think the real prejudice of the Government departments against hot-water heating is due to a wrong application of the system rather than to any defects in the system itself.

Mr. Davis: I think that it is proper that we define what we mean by Government work. This paper, I take it, relates entirely to Treasury Department work, and the specifications approved by the Army Department, the Navy Department, the Interior Department are all different. In some departments cast-iron boilers are allowed and are preferred, but I take it the paper that is under discussion relates entirely to the Treasury Department.

Mr. Weinshank: The paper read by Mr. Thompson has solved a question which I have been asked, namely, why the Government pays more for its work than a private individual.

The remark is made that "It is generally more satisfactory and more economical to purchase steam or water for heating the building than to generate it in the boilers provided." Now that may be true where the Government buys it. It may be true in places where coal is $5 or $7.50 a ton. Take it in Evansville or anywhere in southern Indiana, where you can buy it for $1.35 delivered in your bin, and they charge you 20 cents a square foot for heating per season, and see how you come out.

I had an experience the other day where a party had 7,000 sq. ft. of radiation, and the Central Heating people offered to do it for 20 cents per square foot, or $1,400. "I can do it myself for $500," was the reply. It may be economical from the Government's standpoint, but not always more economical for private use.

Another statement is made which is rather broad. "None of the cast-iron indirect radiators contain the amount of surface claimed for them in the manufacturers' catalogues." I do not agree with that. I have made a number of tests of cast-iron radiators, and in some cases the result was better than the rating. No doubt the Government people measure the surface and consider that there is not enough surface. In comparing direct radiation that may be true, but if the standard of measuring a square foot is the amount of B. T. U. derived from the steam or the amount of heat gotten out of it, then it is not true, as the results from some of my tests show that they do better than they are rated.

There is one point in which I do not quite agree with the Government practice, where it is said that if the amount of radiation is over 3,000 sq. ft. they would use portable steel boilers. I do not know whether any one has had such experience as I have, but wherever we had a portable boiler, the flue gases were somewhere near 850 degrees, and if a steel boiler must be had, I would prefer a horizontal tubular boiler brick set. And while there are a good many fire-box boilers used, I have had very poor results. They are quick steamers, but when it comes to paying for high-priced fuel, I have had very poor experience with them.

The author also says that a safe rule is one pound of coal for each cubic foot of contents of building. Take a building 100 x 60 x 20, a two-story building, according to that rule it would take 120,000 or 60 tons of coal. That is out of the question. A safe rule I have had and used quite often is a quarter of a pound, and that is extravagant; but a pound per cubic foot per season seems to me very extravagant.

Mr. Hallett: With regard to the work-room floors, they are nearly all of them covered with a glass skylight, which is cold, and it is necessary to make some provision under that skylight to prevent drafts and loss of heat. Where you have a hot-water heating system you have to put coils under the skylight to prevent those drafts.

A workroom floor has many openings from which trucks of mail are being pushed either back or forth. So I know from experience that it takes a very large excess of heat in post-office workrooms.

Mr. Davis: Professor Kinealy's point is well taken on the question coming up as to whether we as heating engineers follow the Government practice, and I would like his answer whether outside engineers who are doing work for the Government are asked to live up to those specifications and whether the work done by them is checked up according to those rules. I am quite confident they are not, because I know of large post-office buildings that have been done by outside engineers, and they did not check up at all. For instance, Professor Woodbridge is now preparing plans and specifications for the New York post office, and Pierce, Richardson & Neiler prepared plans for the Chicago post office; Joseph McWilliams & Co. prepared plans for the Indianapolis post office, and I do not believe those specifications were used as a basis.

Mr. Morrin: Referring to the statement: "To this add the following for loss due to leakage; 35 per cent. for office rooms, 65-100 for main lobby, workroom and courtroom, depending on size of room and its use." I think the author should be asked to state what changes of air are required and to base his percentage upon the percentage of air changes. You take, for instance, a lobby in a building five stories high and a lobby for a building two stories high, and in zero weather, without a storm-proof entrance, there would be certainly a great difference in atmospheric pressure at the entrance, where there is zero weather on one side and 70 degrees on the other, that would necessarily make considerable difference in the air change of the lobby, and consequently would require a considerable difference in the amount of radiation, I think considerably more than the percentages that he has asked for here.

Mr. Hallett: They never can be warm. Lobbies are never warm.

Mr. Morrin: Well, you are presuming that this is some particular building you are familiar with. I am presuming you don't know what the building is for or where it is constructed or how. We will presume it has an open elevator or stairway from top to bottom, which will alter the conditions. This is a broad assertion, and we are not presumed to make the conditions—we presume to meet those conditions. I think that the author has left a good, big loophole to fall through.

Mr. Hale: There is a paragraph, "In northern cities where temperature goes below minus 10 degrees, the calculation is based on the lowest temperature reported during the last ten years." Several years ago I asked the question if the Committee on Standards had ever determined what outside temperatures were to be figured in the different localities of the country. That is a condition that I believe is met, and it seems to me it ought to be a part of our records. As far as I know, that has never been put up to the Committee on Standards to report. If it has not been done, I wish it might be.

Professor Kinealy: If the Government says a thing must be so large to carry a certain weight, I know that there are lots of people who think anything any smaller is wrong, even although you may carry a lower factor of safety and be perfectly safe. I want to emphasize the fact that these are the Government rules and are not the rules that are used or adopted by other engineers, and the fact that they are the Government rules does not make them better than other rules. The paper simply shows us what one department of the Government does, and we must be careful to bear in mind that the author is not saying that the Government has made tests, that the Government has done this and done that, and therefore that is so and so. He simply says the Government does so and so, but does not tell us why.

Mr. James Mackay: We must not forget that this paper comes simply from one department of the Government, and that it does not pretend to be an engineering paper. It outlines the practice of one office. And we all know that their practice is deviated from in installation, inspection and carrying out of designs. There is one statement made in this paper of which we can take particular notice. We are informed that hot water does not give good results unless the plant is intelligently operated. This infers that there are other heating systems giving good results while not handled intelligently, and may, in a measure, explain how or why they vary from what we consider good practice.

CCXXIX

CAST IRON HOT-BLAST HEATERS—NEW METHODS IN TESTING AND A NEW MATHEMATICAL FORMULA USED IN PLOTTING CHARTS AND IN FIGURING RESULTS.

BY L. C. SOULE.
(Member of the Society.)

The object of this paper is to describe exhaustive tests conducted last winter on six cast iron blast heaters at Buffalo, N. Y. All of these heaters were of the same general pattern, but differed in the proportion of free air space to heating surface in a stack and in the proportion of free air space to the face of the heater. These tests covered velocities of air through the heaters ranging from 50 ft. per minute to 2,500 ft. per minute. Velocities were derived from actual air measurements with a manometer, and these velocities checked within an average of 2 per cent. with the velocities calculated from the amounts of condensation weighed. The tests also covered heaters ranging in depth from one to seven stacks, and various pressures of steam were used. The outside air during these tests was near the zero mark.

The results of these tests were incorporated in a mathematical deduction, which for the first time properly represents the theory of convection of heat. Former comparisons, made from only one or two sets of conditions, have all been more or less approximate. The majority of the data now published on blast heaters cover their performance under certain conditions of steam pressure with air entering at zero degrees. A few charts show results with air entering the heater at 30 degrees below zero. To determine the performance of a heater with air entering at other temperatures than zero degrees, it has been the custom to make a comparison either of the difference in temperature between steam and entering air, or else the differences

in temperature between the steam and mean temperature of the air passing through the heater. The mathematical deduction above referred to is based on calculus, and the results from these new tests were incorporated in the mathematical deduction.

DESCRIPTION OF APPARATUS.

The heater referred to in this paper is made of sections having cored diamond-shaped projections on each side, as shown

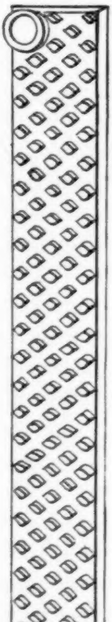

FIG. 1.

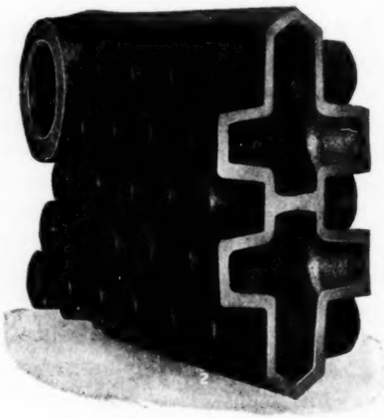

FIG. 2.

in Figures No. 1 and No. 2. The sections are fastened together in stacks by right and left hexagon nipples at top and bottom. The length of the nipple determines the amount of free area in the heater. The three different nipples used give 44 per cent., 52 per cent. and 37 per cent of free area to the face of the heater.

A complete testing plant was erected. Steam was generated in a cast iron sectional boiler under a pressure ranging from 10 lbs. to 30 lbs. pressure. Steam was supplied through a 3-inch main leading from an adjoining building through a special reducing-pressure valve to a 5-inch main to which each of the stacks of heater was connected by a flanged nipple. A steam separator was inserted in the 3-inch line in front of the reducing-pressure valve. The 5-inch low-pressure main and header was covered at first, but, as the majority of the tests were run with 5 lbs. gauge pressure of steam, considerable superheat was found in this header which necessitated the removal of the covering, and the reduction of the pressure carried on the boiler. This boiler pressure was finally set at such a point as to show a temperature of 227 degrees in the steam header and a temperature of 227 degrees in the condensation header, these temperatures being read by calibrated chemical thermometers set in mercury cups into these headers. The air was drawn through the heater by a No. 8 Sirocco fan driven by a 10 horse-power belted motor. The motor ran at a constant speed, and but two different pulleys were used on the fan shaft. The air volume was absolutely controlled by adjusting two dampers in the main discharge pipes from the fan. It was found that by adjusting these dampers and using only two different pulleys on the fan, that the velocity of air through the heater could be regulated to any desired amount. Referring to Figure 3, the fresh air is taken in through the opening "D" provided with a shutter, and passes through the connection "E," which is provided with deflector plates to give an even flow of air to the heater. It then passes through the heater "M," which is provided with a removable jacket. The air then passes through a cone and then through a 36-inch diameter pipe 6 feet long into the fan inlet connection. The sheet iron cone and 36-inch diameter pipe are covered with hair felt 1 inch thick, since the final temperature of the air is taken at "G." At this point were five chemical thermometers for measuring final temperatures, same being located at top, center, bottom and each side of the 36-inch diameter pipe. Readings were taken every 15 minutes, and each test was one hour long, which gave a final temperature equal to the average of 20 readings. It was found by actual test that these

thermometers were too far away from the heater to be affected by radiant heat. Two fresh air thermometers are located at "B," and are protected from radiant heat by one-half round asbestos pipe covering. It was found that on an average thermometer "B," nearest the windows, read 2 degrees lower than thermometer "B" on the front side of the fresh air connection "E." This is due to the absorption of heat from the testing

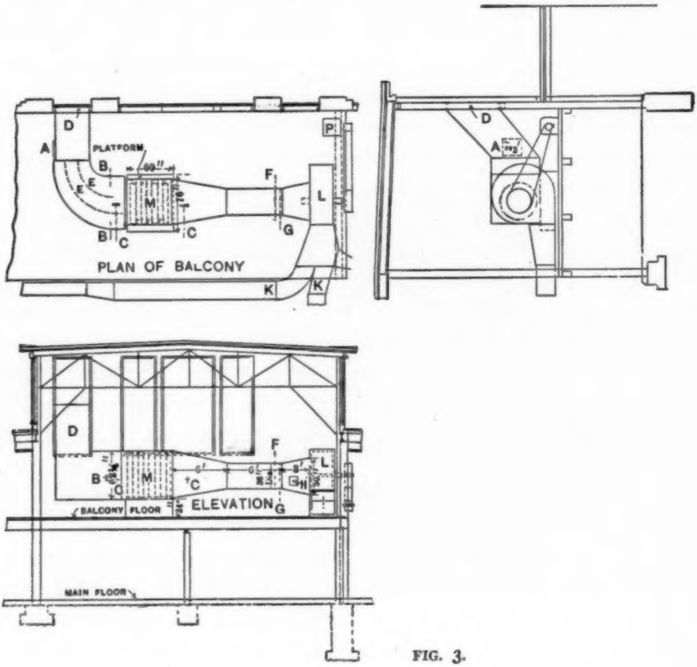

FIG. 3.

room itself, the higher temperature on the front side being caused by the larger surface exposed. An opening was provided at "A" for recirculating the air.

A draft gauge was attached to the sheet iron connection on the fresh air side of the heater. The ends of this draft gauge are connected to static tubes inserted at "C," Figure 3, into the chambers—both on fresh air side and hot air side of the heater. These tubes measure the static pressure in these chambers. The window screen at the tips of these tubes allows only static press-

ure to be registered. In Figure 3 "L" represents the fan, "P" motor and "K" the dampers in the discharge pipe from fan. At "H" is located an opening into which a pane of window glass is inserted. Just inside of this opening is hung a wet and dry bulb thermometer, which measures the percentage

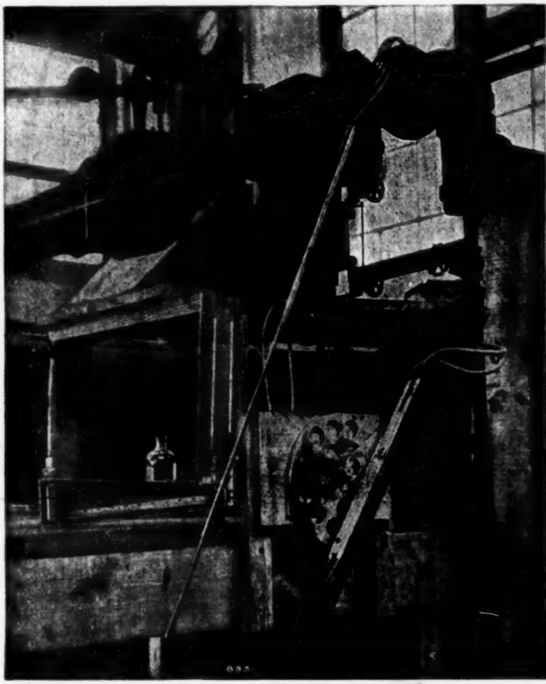

FIG. 4.

of moisture in the blast of air passing into the fan inlet. These thermometers are shown in Figure 4.

Full-sized 2½-inch returns are taken out of each stack and dropped down, in one case, through 2-inch connections into a 3-inch header, and, in another case, through 1½-inch connections into a 2½-inch header. Both pet cocks and air valves are placed on these returns. It was found that the air valves were too small to be of much service, but that the pet cocks were very efficient in letting the air out of the stacks when start-

ing up the plant. These pet cocks were allowed to blow a little —continuously. In each case of starting, steam was turned on the heater driving all the air out before the fan was started up. The stacks were found to be hot throughout, by an observer getting into the fresh air chamber through the recirculating opening. Two return pipes were placed, one along the balcony floor and the other about 2 feet 6 inches above the floor, both connected to the return header. When running the heater by gravity, the valve on return line near heater is open and the condensation flows back to the boiler through the return pipe along the balcony floor. In this case the pressure-reducing valve is blocked open. During a test, however, the pressure-reducing valve operates as desired, and the valve, near return header on the gravity return line, is closed and condensation passes through the upper return line and into the steam jacketed tank. This tank is about 2 feet in diameter by 3 feet high, and there is a 2-inch jacket space around inner chamber. This arrangement of return connections forms a water seal, which prevents steam from any one heater stack backing up through the return into any other stack. To prevent the water being blown out of this seal when drawing off condensation during a test the same pressure is maintained in this steam jacketed tank as in the steam header by an equalizing pipe. The condensation is handled as in a boiler test. The 30-inch glass gauge on the right-hand side of tank is connected with the inner chamber holding the condensation from the heater. The glass gauge on left side of tank shows condensed steam in the jacket, and this condensation is drawn off at intervals into a waste barrel. The condensation is maintained at a certain level in the tank, which level is indicated by a string on the gauge-glass. The test is started and stopped with the condensation registering at this particular height in tank. The condensation passes through a loop in a third barrel next to the wall, where it is cooled by a cold water supply through a hose. This barrel is provided with an overflow to the sewer. This loop cools the condensation down to approximately 180 degrees, so that the evaporation from the top of the two weighing barrels will be practically negligible, and is surely less than would be the error in reading the weighing scales. After passing the cooling loop, the

condensation passes into a swinging loop. Before starting a test this loop hangs over the wooden tank on floor into which it is discharging the condensation. In the meantime the two weighing barrels are tared, and in starting the test the swinging joint is thrown over into one of the weighing barrels. The amount of condensation, at the end of a half hour is taken, and this amount is checked up with the amount for the next half hour.

A 4½ x 2¾ x 4 duplex pump, driven by compressed air, pumps the condensation from the wooden tank on floor back to the boiler through the riser pipe. This riser pipe connects with return line on floor of balcony and down to the boiler in an adjacent building. The steam line is properly dripped into return line.

The entire sheet iron work from the fresh air inlet to the fan is made air-tight, as the air is measured on the suction side of the fan.

In former tests the entering air temperature was taken by a thermometer hung outside the building, whereas the entering air temperature on these tests was taken near the heater. The manometer for measuring the air velocity pressure is located at " F," Figure 3. This manometer measures the pressure due to velocity of air passing that particular point. The area of the pipe at this point is accurately determined. The temperature of air at this point is determined and the weight of air at this temperature taken from a table and corrected for humidity and barometer. From this corrected weight of air and the velocity pressure, the velocity passing point " F," Figure 3, is determined; also the volume. This volume is then reduced to a standard of dry air at 70 degrees and barometer 29.92 inches. This volume, divided by the free area through the heater, gives the velocity through heater in feet per minute at the 70 degree standard. This is all shown on sample test sheet in Figure 5. The velocity is then figured from the condensation and temperature rise, and these two velocity figures check within an average of 2 per cent. In the particular test sheet illustrated in Figure 5, the velocity from manometer readings was 752 feet per minute and figured from condensation was 748 feet per minute.

The manometer used is shown in Figure 6.

In this particular case the air enters at " A " and blower inlet is at " B." When both tubes are attached to water gauge

TESTS OF [illegible] 810 – [illegible] VENTO BLAST SECTIONS

Test No.	10	
Weather	Clear	
Barometer	29.45	Inches
Total Heating Surface	320	Sq. Ft.
Free Area Through Heater	10	Sq. Ft.
Area of Round Section Pipe	7.[illegible]	Sq. Ft.
Centers of Stacks	5	In.
Centers of Loops in Stack	5.375	In.

Date January 20, 1910.

From 9.45 To 10.45

Time	9.50	10.05	10.20	10.35		Average
Boiler Pressure	10	10	10	10		10
Heater Pressure	5	5	5	5		5
Heater Steam Temperature	227	227	227	228		227.25
Heater Condensation Temp.	227	227	227	227		227.
Relative Humidity						24.4%
Depression of Wet Bulb	85 – 61	85 – 62	86 – 63	86 – 62	85.5 – 62 =	23.5
Initial Temp. Entering Air	40 42	40 42	41 43	42 44		41.9
Final Temperature Air Leaving Heater Four Thermometers	85	86	86	86		
	87	88	88	88		
	85	84	85	85		
	86 – 84	85 – 85	87 – 85	87 – 85		85.65
Temperature of Test Room	53	54	55	55		54.25
Revolutions of Fan						200
Friction Loss Thro' Heater (inches of water)	.06	.06	.06	.06		.06

Condensation (lbs.) per Hour 366

Condensation, Lbs. per Square Foot per Hour 1.144

Temperature of Condensation as weighed – 161.5

85.65
41.9
43.75

MANOMETER READINGS

Ratio of Inclination of "U" Tube 20 to 1

Specific Gravity of Gasoline in "U" Tube .74

Readings: (Velocity Inches)	P	N	P	N	P	N	P	N
1	1.9	1.9	1.9	1.7	1.9	1.7	1.9	1.7
2	2.1	2.0	2.2	1.9	2.1	1.9	2.1	1.9
3	2.2	2.0	2.3	2.0	2.1	1.9	2.1	1.9
4	2.2	2.1	2.2	2.0	2.2	2.0	2.1	2.0
5	2.2	2.1	2.2	2.1	2.1	2.0	2.1	2.0
6	2.1	2.1	2.0	2.1	2.0	2.0	2.0	2.0
7	2.0	2.2	2.0	2.1	2.0	2.0	2.0	2.1
8	2.0	2.2	2.0	2.1	2.0	2.1	1.9	2.1
9	2.0	2.0	2.0	2.0	2.0	2.1	2.0	2.0
10	1.9	1.8	1.8	1.7	1.7	1.7	1.7	1.9

$\frac{285}{10.43}$ = 68.4

.07495 x .2375 x 60 x 10 = 10.43

Average Velocity Inches	1.99875
Inches of Water	.07595
Weight of Cubic Foot of Air in Blast	.07135 Velocity Constant – 4105
Velocity—Feet per Minute—(From Manometer Readings)	1116
Volume—Cubic Feet per Minute—(From Manometer Readings)	7927
Equivalent Volume, C. F. M., at 70°	7925 – Standard of Dry Air at 29.92 Barometer
Velocity Thro' Heater at 70° (Feet per Minute)	758
[illegible] from Condensation [illegible]	= 10.4 = $\frac{366}{43.75}$

FIG. 5.

" X," relative readings will be about as shown. Total suction is exerted at " P," and the suction at " N " is the total suction

minus the impact velocity, so that velocity pressure is registered in the "U" tube X.

In measuring the air, the cross section of the 36-inch diameter pipe is divided into zones of equal area, and readings are taken in the center of each zone. In these tests readings were taken at 10 points across the horizontal diameter of the pipe and 10 readings across the vertical diameter of pipe, giving 20 readings every 15 minutes, and the velocity pressure is derived from the average of 80 readings during the one hour test. This instrument has been carefully calibrated and is accurate within 1 or 2 per cent.

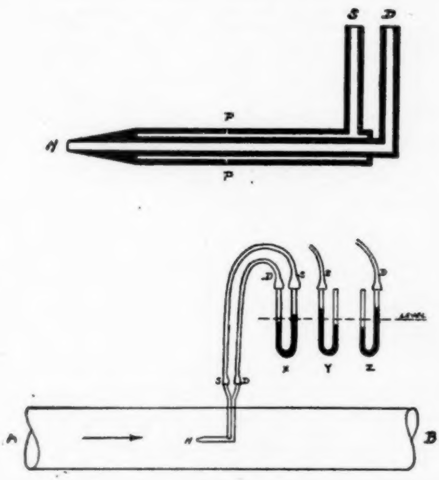

FIG. 6.

The Pitot tube connects with the U tube, as shown in Figure 4. The U tube is attached to a quadrant which allows the U tube to rest in any inclined position, giving a multiplication of the reading of 2 to 1, 5 to 1, 10 to 1 or 20 to 1. During the above tests we used the 20 to 1 multiplication, as indicated in the test sheet. In this U tube gasolene of 0.74 specific gravity is used which gives a very good meniscus and still further multiplies the reading. In every case the tip of the Pitot tube points toward the flow of air. With this tube we measured velocities through the heater ranging from 314 feet per minute to 2,500

feet per minute. At this latter high velocity there was no noise due to the air passing through the heater.

RESULTS OF TESTS.

In order to properly represent the temperature increment due to the air passing over any depth or amount of heating surface,

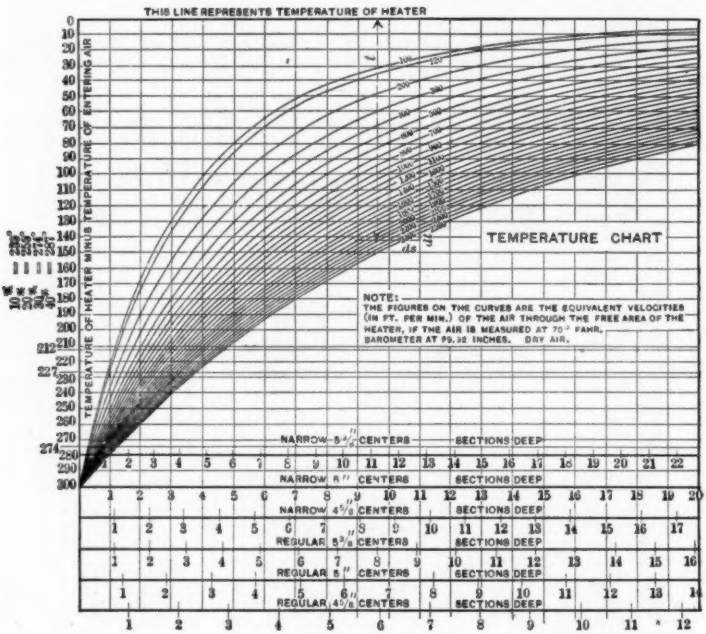

FIG. 7.

it is necessary to derive a formula based on calculus. In Figure 7 the top line represents the temperature of the heater. The ordinates represent temperatures and the abscissæ, distances along the hot surface. Any one of these curved lines represents the temperature of the air as it increases by prolonged contact with the heater. As the air, at a lower temperature than the steam, passes along the hot surface, it gradually becomes warmer—approaching nearer and nearer to the temperature of the steam—reaching this limit when the air has

passed over an infinite length of this hot surface. It will be seen from Figure 7 that any one of these curved lines will become tangent to the top line at an infinite distance. In this sketch, "t" represents the temperature difference between the steam and air at any point, "ds" equals surface of heater, where the temperature difference is "t," "dt" represents the temperature rise corresponding to "ds."

It is necessary to deduce the equation of this curve for various velocities of the air.

The mathematical formula used for this purpose was deduced by L. A. Cherry, of Vanderbilt University. This formula makes use of previous formulæ deduced by well-known authorities, as follows:

Years ago Dulong and Petit devised a formula to represent the quantity of heat lost from a unit area by a hot body in a given time. This quantity of heat is a combination of amount lost by radiation and amount lost by convection. The amount lost by convection:

$F = Bh^c\ (T - \theta)^{1.233}$, where

B is a coefficient which depends on the form and dimensions of the surface.

T, the temperature of the hot body;

θ, the temperature of the surrounding gas;

h, the pressure of the surrounding gas;

c, a number which depends on the nature of the gas.

As R (the radiant heat) has no perceptible influence on warming the air passing over the surface, the quantity F is the controlling factor.

The above equation of "F" was quoted by Rankine.

The formulæ for "R" and "F" were simplified by Peclet, and afterwards verified by Ser. The value of "F" was as follows:

$F = 0.552\ f\ S\ (T - \theta)^{1.233.}$

This value of "F" is quoted by Carpenter, page 83.

S represents the surface of the body and "f" the coefficient of convection. The values of "f" are shown as ordinates in Figure 8.

Mr. Cherry's value of "f," as applied to these particular tests is as follows, after integration:

$$f = \frac{0.2375}{0.4814 \times 0.233} \times \frac{W}{S} \left[\frac{1}{t^{0.233}} \right]_{t_o}^{t_s}$$

Where W = weight (in pounds) of air passing over surface per hour. Now W = v x A x 60 x 0.07495.

Where v = velocity of air through heater in feet per minute measured at 70 degrees.

A = " free area " of heater in square feet.

0.07495 = weight of one cubic foot of air at 70 degrees Fahrenheit.

Also—

S = s x b x d where

s = sq. ft. of heating surface per section;

b = width of heater in sections;

d = depth of heater in sections.

The various values of t_s represent the difference between tem-

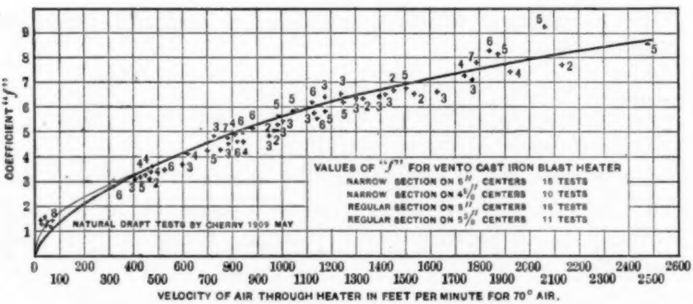

FIG. 8.

perature of steam in the heater and the final temperature of the air leaving the heater. Similarly the values of t_o represent the difference between the temperature of steam in the heater and the temperature of the air entering the heater.

Solving for " f " with the values taken direct from the tests, we determine points, as shown in Figure 8, from which we construct the coefficient curve as shown. It will be noted that each one of these points along this curve represents a test of one hour's

duration. Seventy-one tests were made, at varying velocities and with various numbers of stacks in depth, with various free areas and steam pressures, and with the air entering the heater at whatever outside temperature was available. Eight previous tests made on this heater under natural draft conditions were plotted on this same coefficient chart, the velocities ranging from 34 feet per minute to 77 feet per minute. It made no difference regarding the number of stacks deep as to its coefficient. These tests show that a series of tests could be run on a heater of one certain depth and the values determined by this coefficient chart for any other depth of heater. It is of especial interest to note that these test points, under all these varying conditions, follow along this same coefficient line.

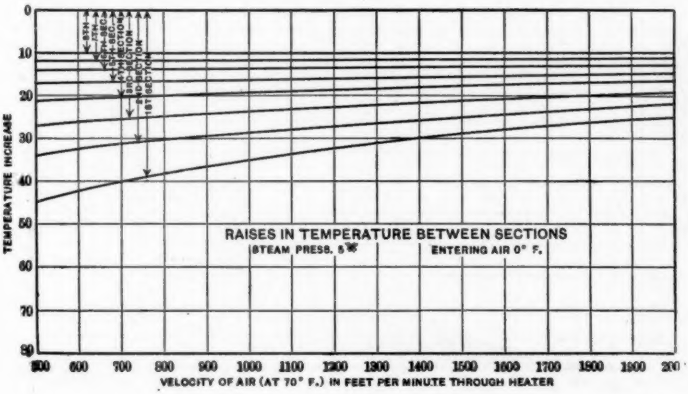

FIG. 10.

At the bottom of chart shown in Figure 7 the six horizontal lines with the numbers thereon indicate the depth in stacks of six different heaters. From this temperature chart there have been prepared fourteen tables showing the temperature rise and condensation in pounds per square foot per hour for these six different heaters under various conditions of air entering heater, both below zero and above zero, and under varying conditions of steam pressure and with velocities of air through heater ranging from zero to 2,000 feet per minute. The condensation values in these tables are taken from chart shown in Figure 9.

Figure 10 shows the rises in temperature between stacks of this heater under one certain set of conditions. The object of this chart is to show the greater heating effect of the first stacks over which the air passes as compared with the effect of the air passing over the last stacks. This chart is made up from chart in Figure 7, and shows the regular increase in temperature at varying velocities. Special attention is directed to this chart, as previous blast heater charts, if plotted in this way, would show very irregular curves.

Figure 11 shows the friction loss in inches of water due to

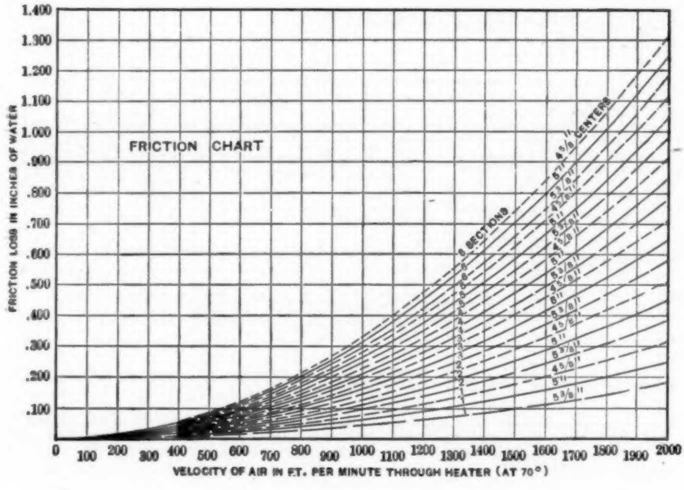

FIG. II.

the air passing through three of these heaters having different free areas, and the values are given for any velocity of air.

Mr. Cherry applied his formula to one heater only, operating under one steam pressure, but the writer has shown that this formula applies to heaters having various free areas and to heaters of varying depth of section corresponding to 2-row and 4-row pipe coil sections; also that it applies to different steam pressures.

The data which have been compiled by the writer from these

tests and this mathematical formula are intended to cover all blast-heating conditions; and the writer's personal superintendence of these tests allowed him to obtain such results, it is thought, as have been desired for some time past by engineers of this profession.

DISCUSSION.

Mr. Macon: I would like to ask the author if he will not explain somewhat the derivation of some of the formulas. It strikes me as a rather abrupt introduction of the formula of the coefficient of convection on page 300.

Do the letters P in the cut of the Pitot tube indicate that there are openings at those points?

Mr. Soule: Yes, two openings of 1-200 in. in diameter, just merely pinholes. Regarding the formula, it is not my formula. It is rather necessary to have the permission of the man who made it.

Professor Kinealy: I would like to ask the author if the air volume cannot be determined from the different pressure readings?

Mr. Soule: The manometer with the inclined U tube measures the amount of air passing that 36-in. pipe, and that was a separate apparatus from the draft gauge itself.

Professor Kinealy: From that you can determine the amount of air passing through the heater?

Mr. Soule: I expect that can be done, although I did not use that in my calculations.

Professor Kinealy: If you know the pressure of the air this chart gives the volume. Knowing that, you can determine the amount of air in cubic feet?

Mr. Soule: Yes.

Professor Kinealy: So it makes it very easy to determine, and when the sections are all standardized it becomes a very easy problem to calculate the amount of air that the apparatus is delivering.

Mr. Soule: I would like to say that I am indebted to Professor

Kinealy for the form of construction of that draft gauge in measuring the friction. I used the same kind of instrument that he used two years ago.

Mr. Donnelly: I would like to know if the author made any tests to determine the effect of humidity on the results obtained? I also wish to inquire if any correction was made for the drop in temperature of the condensation?

Mr. Soule: Regarding the humidity, there was no test made on that except to measure what the humidity was—of the air passing the point where we took the temperature and measured the velocity. Of course the humidity could be determined at any point if we had a tempering coil and reheater.

Mr. Donnelly: How would the convection vary with different amounts of humidity?

Mr. Soule: I made no test to show how that would vary with the humidity; I simply used the humidity reading in reducing the air volume to a standard of dry air at a standard temperature. Regarding the condensation, it flows to the steam jacketed tank through the return connection, which is covered with about one or two inches thick of hair felt, clear up to the heater casing. The entire return line is covered, and there is practically no drop in temperature of the condensation, or at least, in the heater where it is going to have any contact with the air. The amount of water that could remain in the bottom of those sections is very trifling, and it would be only a very small percentage of the total water being condensed.

Mr. Donnelly: How does the cut represent the heat when the temperature of the steam which passes the heater is 227? I doubt if the temperature of the water would be above 200, and that a difference of 27 degrees or 27 B. T. U. per pound of water should be added to the amount of steam condensed by the hot blast section before this coefficient of transmission is taken, because there is just that much more heat taken away. To get that you would have to get the temperature of the water leaving the heater. I ask whether the temperature of the water leaving the heater had been taken?

Mr. Soule: The amount of water which may be in this heater at any time during the test is in the presence of steam at the pressure used in the test, and there would be no drop in its tem-

perature to amount to anything. The drop in temperature of the condensation, if anything, is hardly enough to bother with.

Mr. Morrin: I would like to inquire where is the best place to take the air measurements on a blast apparatus?

Mr. Soule: Most of the air measurements with the manometer are taken on the discharge side of the fan, and to get the proper readings there should be a pipe about 30 feet long, a round iron pipe, connected with the fan outlet, and the Pitot tube should be inserted about 20 feet from the fan outlet and, say, ten readings taken across each diameter. Of course in an actual installation you cannot get that. I could not get it myself on this test, so I had to take the readings on the suction side of the fan. In order to do that, I had to make the entire apparatus air-tight from the fresh-air inlet to the fan. I took those readings at about four feet from the fan inlet. At that point there was a straight pipe, 36 inches in diameter and about 6 feet long. I took my readings right at the joint between the cone to the fan inlet and the 36-inch pipe. I found no eddy currents there at any test velocity. I did find that, when running at low volume, with a 20-inch pulley on the fan, that the air was churned so that I had actually a negative reading on the manometer. I changed to a 24-inch pulley and got a positive reading immediately.

Mr. Morrin: What pressure would the air manometer register on the higher speed?

Mr. Soule: Well, it is measured in inches of water. For example, this low pressure here was 27-100 in. of water. The manometer reading is multiplied 20 times by inclining the quadrant and U tube and the benzine in the U tube, being only 0.74 specific gravity, still further multiplies the reading. You can see, by referring to the test sheet, that the manometer readings are very constant.

I think that with a plant installed in a building, you will have to measure the air at the outlets to the rooms or at the fresh air inlet. It is generally found inconvenient to use the Pitot tube on an actual installation. We not only measured the air, but we calculated the air from the condensation weighed—and the results from these two methods checked within an average of two per cent.

Mr. Collins: That was practically the same then. Would not

this condensation test be much simpler than taking those eighty readings per hour?

Mr. Soule: Well, I wanted to show myself—and thought it might be of interest to other people to know—that you could make the manometer figures agree with the figures on condensation. One or two people have raised the question with me whether it was the right way to do to figure the air volume from the condensation and said, "We would like to see it on the manometer." So I got it both ways.

Mr. Macon: Where is the greatest difficulty in measuring air, in getting the results with the condensation or with the Pitot tube? Suppose we had the necessity of testing a given fan heater outfit. Owing to the simplicity of measuring the condensation and temperature rise, that would be, as Mr. Collins points out, a relatively quick way of getting it, but would not we have a chance of error?

Mr. Soule: None whatever in getting either one of them, either getting the velocity of the air with the Pitot tube or from the temperature rise and the condensation. One time I would have oil in the boiler and be getting loads of water over and knocking the test out, and another time some workmen would leave a big hole in the casing and let a lot of air through, and I would get about 25 per cent. more air than the condensation showed. I had to get the whole testing outfit tuned up to make the results agree. After I got it tuned up, it ran all right. I think both of these methods of measurement are necessary, one to check the other.

Mr. Macon: You would not undertake any further tests then without using both methods?

Mr. Soule: No, I would not.

Mr. J. H. Davis: I would like to ask Mr. Soule if that Pitot tube is not the one that was used in New York for testing the drafts of battleships and in other tests?

Mr. Soule: I cannot say. It is used by the Government. They use the same type of tube, except in each side there is a slot for measuring static pressure, instead of a pinhole. They use a tank, an inverted cylinder and a tank of water and measuring scales for determining air velocity from the pressure. But it has been shown, by testing out, that the Government Pitot

tube is in error by a good many per cent., due to those slots registering static pressure. That error can be corrected by binding a fine mesh wire screen around the tube, in which case the instrument becomes accurate within one or two per cent. This Government tube with the wire screen bound around the slots is the only accurate type that I know of—outside of the type which I used.

Mr. Hale: Mr. Soule refers to the cut in the supplementary sheet in reference to the pet-cocks and the air valves provided, and states that these are allowed to run open continuously. I would like to ask how long it took to extract the air or force the air out of the coil before the test was taken, and if any attempt had been made to test this under conditions where a vacuum pump was used.

Mr. Soule: We could generally exhaust the air in about ten minutes. We would turn the steam on the heater and get all adjustments made, and then let a man get inside the casings and see that the stacks were all hot. While that was going on we would have the pet-cocks opened up wide. As soon as the stacks were hot, we would nearly close them so as to let just a little steam ooze out. We have never made a test with a vacuum system.

Mr. Macon: I want to ask the author if one of the particularly important findings of the tests is not the fact that a series of tests can be run on a heater of one certain depth and values determined by this coefficient for any other depth of heater? It seems to me that is rather a remarkable statement.

Mr. Soule: Mr. President, that was the most interesting thing about the whole series of tests. On the chart which we have in the paper I regret that one cannot recognize the test points; but this one coefficient curve takes in 1 to 7 stacks deep on 6 different heaters and 2 different steam pressures, and gives results under every condition of air velocity and temperature of entering air. All of the 51 tests are plotted on this curve. Down here I show high-pressure steam test points with circles around them. Here is a narrow section corresponding to a 2-row pipe coil, 6 stacks deep, 5 pounds of steam. I don't know what was the entering air temperature. At the right side of it is a 2-stack deep test point with the regular section using high-pressure steam. It does

not make any difference what they are, they all follow along this same curve. It is a varying coefficient of convection. The coefficient varies according to velocity, and that simply shows that it is not necessary to run tests on one, two, three or six or seven stacks deep or sections of pipe coils or anything of the sort. Just set up one heater and run a series of tests and plot the results for all the heaters.

CCXXX.

TOPICAL DISCUSSIONS.

TOPIC NO. I.

The Relative Merit in Efficiency and Sanitary Effect of Furnace-Heated Air and Air Heated by Steam and Hot-Water Radiation.

Mr. Morrin: This is a subject that is practically the contention of the Board of Education of San Francisco. As you know, we have just recovered from a very extensive fire there, which necessitated the building of many new school buildings. Some of the schools are equipped with air-heating furnaces and others with the modern arrangement of low-pressure cast-iron sectional steam boilers or coils of cast-iron sectional heaters in conjunction with fans and automatic temperature control. All of the schools are planned practically on the same style—a trifle difference in the design of some. There are some differences in the sizes, but the scheme, on the whole, is the same, except for the heating units difference. So far all the systems are new. We have not discovered any defects in either of them. But a decided prejudice has grown up among our officials, particularly the officers in immediate charge, in favor of the furnace-heated systems.

In regard to this I was before the Board with three of the heating and ventilating engineers of our city a week ago to-day, and the most decided and bitter prejudice exists in the board, particularly in the person of the superintendent of education, in favor of furnaces. I raised the point before the board that the heating furnaces, while new and operated at moderate temperature, were not necessarily objectionable. But the uncertainty of the future life of the furnaces and the uncertainty of the actual conditions of the air passing over the furnaces or leaving the furnaces for the schoolrooms was dependent entirely on the number of leaks in that furnace; that is, the leaks between the com-

bustion chambers and the outward air chambers, and that the matter of the quality of the air could only be obtained by a careful test, and that test was never asked. There was no one in authority to demand it. There was no authorization in our charter that would permit the school board to investigate it. The Board of Health, I believe, has full authority, but there again is a barrier because of the differences between the two boards, or the difference of opinion between two persons on either board would seldom if ever bring about these results or the possibility of having periodical tests of the air in the different schools. As an instance, I stated to them that CO_2 was colorless, and odorless, but extremely dangerous; and that if one should inspect a steam boiler in service, if there was a leak in it it would be immediately detected by the noise or the appearance of the steam; but all the people on earth might open the door of a defective furnace and they could detect nothing in the form of a leak that might endanger the health of the children or teachers.

The prejudice in favor of furnaces got so strong that the Board of Education notified the Board of Public Works, who have the construction of the schools, that they would not receive or accept from them schools that were equipped with anything but air-heating furnaces.

As a matter of information for myself or the good of the order and benefit of our community I would like to hear the sentiments of those present on this subject.

Mr. Bryan: In both cases were fans for distributing the air used and were they motor driven?

Mr. Morrin: I answer that they were. The mechanical equipment was identical in each instance, and also the thermostatic control was used in each school, and I might add that in two or three steam units that I had the honor to design, air washers were installed.

Mr. Macon: I want to ask if the question of leakage of gases in furnaces is not really about overdone. I should assume that in the greater period of time in which a furnace is in operation that the tendency of the movement of gases would be inward into the combustion chamber. When the temperature of the smoke pipe is a good deal hotter than in the air flues and the

draft of the fire is therefore greater, the pressure in the combustion chamber is much more below that of the atmosphere than the warm air passages, and on that account there is a tendency for such leakage gas or air as may occur to pass up the chimney, except in times of firing, when the fire door is open.

On the same line I would like to make the suggestion that if we call on Dr. Colbert, the engineer of the Federal Furnace League, we may get some information. And on this subject I want to mention a recent interesting conversation I had with a furnace manufacturer and a manufacturer of chemicals and fertilizers and a chemical engineer, of Warsaw, Poland, who, as I understand it, is very pronounced on the question of proper humidification in connection with the warm air furnace. I am speaking of this because the topic refers to the difference in the sanitary effect of air heated by warm-air furnaces as compared with that heated by the steam or hot-water installation. This Polish gentleman is emphatic in stating that the water receptacles should be placed low. As I understand his theory, it is, in fact, he claims to have proved it by his experience, that each particle of dust will be wrapped with a thin film of moisture and that this vapor acts as an insulating medium when the dust particles reach the heating surface. Then he points out the heating surfaces are unable to dissociate or induce oxidation or combustion of the dust particles. He states that when the dust which comes into the air, which we get from wool fibre or clothing or street débris, comes in contact with the heating surface, we have such an organic compound as acrolein formed. And his experience is that acrolein is decidedly irritating to the mucous membrane, and has a tendency to disease propagation. His idea also is that we should not force the air to become too highly heated.

Mr. Lewis: I have never been able, and I have had quite a good deal of experience with heaters, to detect any great difference in the quality of the air delivered, although I have found a great difference in the amount of fuel used in equal sized installations with automatic regulation between furnaces and steam. I account for it to some extent by the fact that in the steam plant when the automatic dampers shut off there is no air passing through the steam coils. The steam is not con-

densed in the heater coil; it therefore accumulates in the boiler. Pretty soon the gauge serves notice on the janitor that he should ease up on his draft. If he does not do that the safety valve will soon blow off and give notice. With furnaces there is nothing to prevent his firing the plant all day long as hard as he can, no matter what the automatic regulation is doing with the mixing dampers.

Mr. James Mackay: As to the difference in the quality of air, furnaces as made to-day contain a very small amount of heating surface. If we had in a warm-air furnace the same amount of heating surface as we have in a system of steam or water radiators and carried the furnace at the same temperature as the radiators, there would be very little if any difference in the air. But such a furnace would cost considerably more than the present market price of furnaces. Take a building requiring 600 square feet of water-heating surface, a warm-air furnace put in to heat this building would contain 60 or 70 square feet of surface. Now it goes without saying that if 60 or 70, or even 100, square feet of heating surface in a warm-air furnace does the work of 600 square feet of water-heating surface it must be carried at a high temperature. If it is carried at a high enough temperature to do the work there must be a great strain upon the innumerable metal joints that make up that furnace. With the smoke flues of the furnace open, there would be very little if any carbon dioxide mix with the air in the rooms, but the trouble is that the outlet flues are not always operated under the ideal conditions that Mr. Macon recommends. They are frequently checked off or choked up. In many cases brought to my notice, when the furnace casing was taken off it was found that the furnace was covered over with half an inch of fine white soot or ashes, which came from the fire chamber or ash pit. Under such conditions, if the vent flue were checked for half an hour there would be some danger.

Mr. Pittlekow: The point of leakage I think would be overcome by having a higher pressure in your plenum chamber than in your combustion chamber, giving no chance for your gas of getting into the fresh air portion of your furnace. I had some experience three or four years ago in that line. We changed the fan around, the cool air fan, and blew the air instead of

drawing the air through it. Mr. Lewis in his discussion I think overlooked the fact that in the schools the apparatus was automatically controlled.

Mr. Bryan: I would like to ask Mr. Lewis in the first place about what that difference was, the hot-air furnace over the steam plant, under substantially the same conditions.

Mr. Lewis: I have known it to vary all the way from 20 per cent. to 150 per cent. I would like to ask Mr. Morrin if there were any objections made as to the possibility of leakage of gases into the air used for ventilating.

Mr. Morrin: Objection was raised because of the destructive effect after an explosion, possibly; the destructive effect of a boiler explosion and the necessity for the school operators to maintain the system. As to cost, the relative cost of three schools, one using oil and two using coal for fuel, the one using oil and one of those using coal were both steam units, the third one was hot-air unit. The first cost $1.80 per day, and the second $2.50 for fuel, and the third, the hot-air one, $8.20. To the $1.80 must be added the cost of operating a 2-horse-power motor for operating the oil pump and the air compressor, which would just about balance the actual cost for the two steam boilers. The relative cost of maintenance of the two, basing the steam equipment upon the natural life of twenty-five years and the hot air upon a natural life of fifteen years, the cost per year for maintenance would be as $9 is to $88, presuming that the average life of the sections would be based upon what some one more familiar with the apparatus than I had averaged in his personal experience. The effect of constant heating and cooling of the furnace and boiler would be very destructive upon the furnace. The furnace was built with a plenum chamber, the cold air entering at the bottom and the hot air passing out at the top, with mixing dampers identically the same as would be for a steam plenum chamber. And, by the way, these furnaces are limited in heating surface. They do not average over 30 to 1 in the ratio of heating surface to grate surface.

From a fuel point of view it shows a marked inefficiency. But for every change of air in that room you would have a different degree of gases; there would be more or less condensation, and the moment the temperature lowers to a point where

condensation takes place it has a very vicious action on the metal of the smoke-flue, will perforate it, spring leaks, and you will get diffusion just the same.

From the fuel point of efficiency it has been my experience that the furnace continues to consume its fuel. If you place that furnace on an automatic damper, under thermostatic control, then you are compounding the trouble that we are trying to avoid. You will then create the same pressure within the furnace, after the damper closes, that you have outside, and you will get into more trouble.

Now as to the matter of contraction and expansion. The hot-air furnace is no more exempt from that than the steam boiler, but it is less distressed. The cold air passing in at the bottom or at the top, if you will, one side is bound to be colder than the other, and to save the efficiency of the furnace you must necessarily introduce that air from the bottom. You will then have an unbalanced effect, a constant expansion and contraction of that furnace. You can use what putty you will, you can rivet the joints if you please, you can cover those joints with most any metal contrivance you wish, and I have yet to see a furnace that has remained tight for a period of six months. When I say tight, I say perfectly tight, that an ordinary simple test of the furnace will not show you a proportion of carbon dioxide that is objectionable; I do not say necessarily dangerous, but objectionable.

As to insurance, I do not think the underwriters have raised that question. As to explosions, we have records of several thousand boiler explosions, and I have copies of a circular that was issued by the Hartford Steam Boiler Insurance Company showing destructive explosions. I doubt if they recorded any loss of life, but we ourselves, with the limited data at our hands, are unable to discover any single instance where the explosion of a low-pressure boiler did cause loss of life. In this, however, I say our data was limited. We were not certain of our position.

The President: I take this occasion to call on Dr. Colbert, as suggested.

Dr. Colbert: Mr. Chairman and Gentlemen: The question that has been brought up for discussion is one that is so large and one that has received so little investigation that I do not think

we can reach any definite conclusion at the present time. I will just try to bring up points as they occur to me.

The white fuzz on the outside of the furnace that was mentioned is not due to leakage from the combustion chamber, but is due to partial incineration of dust particles; and you will find that white fuzz on the cast-iron furnace more pronounced than you will on the smooth steel furnace, because the rough surface of the cast iron tends to the collection of dust particles. I grant you that with steam radiation you do not find that incinerated dust; but from the standpoint of the physician I question which is the more harmful, the small percentage of gas given off from incineration or the dust itself. In the one case you have a slight effect from the gas, in the other case you have a deposit of dust in the lungs, and dust that gets into the lungs is never exhaled, at least only a very small portion of it is, the balance remains, is taken up and deposited in the air cells and lymph glands and tends to the inoculation of the bacillus tuberculosis and other germs, which usually enter the body by these channels. In fact, the best defence we have against tuberculosis at the present time is the maintenance of the lymph glands in good condition, for that is where the tuberculosis germs and other germs will settle and where most germs are destroyed.

The question raised on outward leakage from gas chambers of furnaces has been of a great deal of value. Mr. Macon takes an excellent stand on the point. I do not want to be quoted as having said that every furnace that has ever been manufactured or every furnace that is manufactured will not leak gas. But I do wish to say that it is possible to so pack the joints of furnaces that they will not leak gas. That has been thoroughly proved by tests in which the dust was excluded from the incoming air. If the furnace is adjusted so as to exclude all the dust from the incoming air, absolutely the only change taking place in the air then is the lowering of the relative humidity and the diminution in the quantity of ozone contained in the air, if there was any ozone originally present. Of course tests conducted in laboratories, which are usually located in cities, will not clearly show the diminution in ozone, because it is a well-known fact that there is no ozone in city air.

I think while I am on my feet I might bring up a subject for

discussion that chimes in very well with the matter which you have in hand, and that is that as a Society of Ventilating Engineers you should not limit your investigations to the quantity of air that may be introduced into a building or exhausted from a building in a given time. To produce hygienic results, you should also devote your time to finding out how you may bring the air into a heated building in practically the same condition that you find it outdoors. I may say that the securing of the passage of laws governing ventilation at the present time is very valuable, but we are liable to get into trouble through our lack of knowledge of proper standards.

The objection is raised that ventilation costs money. Ventilation with the methods of introducing heated air that we now use does cost money. It is a mighty expensive proposition. If you will look over the tests that have been made by various hygienists, you will find that some state that a full-grown man requires not more than 500 feet of fresh air per hour; you will find that others say that a full-grown man requires 3,600 cu. ft. of fresh air per hour; and the accuracy of those men is not to be questioned. From some investigations of the subject I have reached the conclusion that the amount of fresh air required by a man depends entirely upon the quality of air that you deliver to him and the methods of delivery. But I think that members of this Society, by devoting a portion of their energy to efforts to improve the quality and distribution of fresh heated air, will make great advances in the matter of ventilation, and unquestionably do themselves a great amount of good; because the determination of the amount and distribution of fresh air cannot be safely entrusted to the ordinary heating contractor.

I have had in mind for some time past the improved results that would be obtained by this Society by including in its membership such men as Dr. Evans, of Chicago; Dr. Neff, of Philadelphia, and Dr. Dixon, the State Health officer of Pennsylvania. They would be a very valuable addition to your membership roll. For after all, it is only by the practical application of knowledge of hygiene that the best results can be obtained in the development of the science of ventilation; and I submit that the health officers of cities or States are the men who are qualified to help you to secure those results.

Mr. Lewis: I do not want you to go under the impression that I am against furnaces. I believe that there is a great future for furnaces, and that if the people would use the energy and spend the time and study on the development of furnaces that we put into the development of steam and hot-water heating plants, we could at least equal the economy, which is the prime condition now in the school-house work, of the steam plant. It is in getting high temperature of combustion, it is in so constructing furnaces that the products of combustion are robbed of their heat before they get away that economy depends. While I admit that the quality of the air is important, even more important is how that air is introduced into the room, and I think the wide variance of experts in stating the amount of air required per capita is accounted for by the method in which the air is introduced. For instance, if we put in a schoolroom, in front of each pupil, a small pipe blowing fresh air into his face and another pipe taking the expired air away, it is doubtful if we would require any 30 cu. ft, per minute.

Secretary Mackay: Mr. President, I have heated a good many buildings, some with hot air, some with steam, and some with hot-water apparatus, a large number of churches and schools, and yet I have a number of cases in view where this particular thing has been found. I have one instance of a large school in Massachusetts which was formerly heated with five hot-air furnaces, a high school building, two furnaces at each end and one in the centre. They were a modern make of furnace, well placed in brick chambers. They did not have any exhaust fans, but had aspirating shafts. It was thought that the furnaces had worn or worked themselves out, and I was called in to design a steam-heating apparatus to take their place. The only time I could have access to the building was on Saturday, and I found that it was the common practice of the janitor to fill those furnaces up on Friday night, shut off the dampers tight and leave them to heat the building to a fair degree of temperature to keep the plumbing from freezing until Monday morning. The building, when we were in it on Saturday, was positively unbearable with coal gas, which had worked up through the body of the furnace and up through the pipes into the rooms, and we had to open the windows before we could exist in it. It was

sufficient to asphyxiate any one. The wrong operation of an overloaded or defective furnace is going to give foul air in a room which it would take a week to work out; and you would never have pure air, even when you are bringing it in in large volume and running it with the smoke-pipe full open; for the walls of the room would get so thoroughly permeated with coal gas that it would have objectionable effects on the lives and minds of the pupils.

Mr. Weinshank: I want to answer my friend from California and say to him that he is going through all the ailments of the heating experience as we did twenty years ago. Twenty years ago we said the stove must go. We then got the furnace. Eighteen years ago we said the furnace must go. We got steam, and we can have the result we want. We can control the results, we can design the results and get them. You can design a good furnace under some conditions; but as long as we can have a hot-blast steam system properly designed, no one can persuade me or any other thinking man that even a good furnace is just as good as a good steam plant. We say that we can get along with the furnace, but we only say it when we cannot afford to install a steam plant.

Professor Kinealy: It has been my good fortune to be called upon on several occasions to make tests of hot-blast systems where furnaces were used to heat the air. I remember one in particular where the test extended over a period of more than a month, and I tested the air on several days. I could find nothing in the air ordinarily to show that the furnace was having a deleterious effect upon it. On Monday morning, after the furnace had been idle for possibly twenty-four hours or more, and on other days when the furnace had been idle for a day or more, there would be an odor that I thought was due to the burning of dust accumulated on the furnace surfaces. The furnaces in this particular instance were cast iron, and I examined them carefully inside and outside. They were located in a plenum chamber. The pressure in the plenum chamber and the draft of the chimney were such that there was no leakage of gases outward from the combustion chamber into the plenum chamber. There was some leakage of air from the plenum chamber into the furnace proper. The difficulty was to get an equal distribu-

tion of the air over the heating surface of the furnaces. There were four large furnaces. The fan outlet was about four feet square and the fan discharged directly into the plenum chamber. The furnaces were set side by side, and they probably had a front of fifteen or twenty feet, as they were very large furnaces. The result was that the middle furnaces got nearly all of the air; the two end furnaces were often red hot and were very rusty. The apparatus failed to heat the building. Some rooms were often very hot and other rooms were always cold. The air coming direct from the hot parts of the plenum chamber would be very hot, and that from other parts would be very cold. This was a large installation, and the trouble was, as I thought, that the furnaces were not sufficiently large for the work, and that they had not been properly put in. I think if the air had been discharged onto one of the furnaces and made to pass back and forth over the others, thus passing over the furnaces in series, better results would have been obtained. It seems to me, however, that the furnacemen have not yet given us a furnace that is adapted to large fan installations.

Mr. James Mackay: Mr. Lewis is right when he says that the furnace properly worked out has a great future before it. I also agree with Dr. Colbert that furnace joints can be made so they will last many years and resist the passage of gas, provided that they are not overheated. As a rule, there is not enough heating surface inside the furnace, on this account they must be overheated, and then they leak gas.

Mr. Morrin: In answer to the doctor's suggestion that 500 feet of air per minute is sufficient, I think myself at times we are handling more air than there is any necessity of. I have in mind a theatre in San Francisco where we took great pains to diffuse the air over the entire surface of the building, not only over the gallery but below the gallery, and I know that they got very satisfactory results there with very much less than the standard requirements; also a café in San Francisco, where the ventilation only, according to our standard, was sufficient for fifty people. (1,800 cu. ft. per minute.) Well, I have seen 125 people in there at a time, and everybody was comfortable.

TOPIC NO. 2.

The Science of Acoustics and Its Relation to Heating and Ventilation.

Mr. Morrin: The motive that prompted this query came from the fact that I was asked to investigate the conditions in a building where the acoustics was very, very bad. About this time an article appeared in one of the technical papers giving the results of a thorough system of discovering those defects in a building in Paris. I had to go to the building to learn what was required of it, and while there several demonstrations by the use of musical instruments and people speaking in different parts of the building demonstrated the fact that there was a most annoying echo from several different points; and where there was more than one person speaking at a time there was, in fact, an echo of every different sound. While I did not take part or make any attempt to discover the cause of the echoes, it occurred to me that it was a most interesting subject, and one that the heating and ventilating engineer has a good opportunity to take up in his profession, as it pertains particularly to buildings, and buildings that come within the class of churches and theatres, where the heating engineer is usually employed. I asked the question to bring the question formally before our members and ask for their opinion.

Professor Kinealy: I have had occasion to look into the question of interference of air, or ventilating apparatus, rather, with the acoustics of audience halls. In one case the air was supplied to the hall from openings just in front of and under the stage. In the other case a large part of the air was supplied through the floor directly in front of the stage. But in neither case did the entering air affect in any way the acoustics of the hall. It was, so far as I could tell, exactly the same, whether the ventilating system was running or at rest. I have yet to find a hall where the acoustics has been interfered with by the supply of air for ventilating purposes. I have heard of such places, and I have, as I said, examined two very carefully. I have looked over possibly half a dozen others in a casual way, however, and I do not think that where a hall has poor acoustic properties that it is due at all to the ventilating devices or the way in which the air is introduced.

Mr. Macon: Professor Sabine, of Harvard University, has given some experiences where a heated column of air interferes with the proper transmission of sound, and one of those experiments was made by Mr. Jenney, the architect of Chicago. He says that it is altogether unnecessary to attempt to move the air in the direction in which the voice or the sound is supposed to carry; that the sound travels rapidly, say, 1,000 ft. per second, and if we were to try to ventilate an auditorium and attempt to push the air all forward from the stage at perhaps 10 ft. per second, the effect would be equal to that accomplished by turning the body or ear just a little nearer to the stage. He explains there that with higher temperature of air in the upper part of the auditorium, with that kind of ventilation, there would be a tendency to force the sound waves downward toward the back of the room, but it is really infinitesimal in any acoustic proposition.

Mr. Hale: The remarks made by Mr. Macon brought to mind an experience I had some years ago with W. L. B. Jenney, the Chicago architect whom he mentions. I was working on a plan for the heating of a theatre, and I had placed two radiators in front of the stage. When I submitted the drawing to Mr. Jenney he gave me a long lecture on the acoustic properties of a theatre, stating that the heat rising from those radiators would form a curtain between the people on the stage and the audience and interfere with sound carrying. He stated at that time that the best practice was to admit the air on the sides of the stage and take the ventilation out, so that the travel would be toward the audience. I have always remembered it.

Mr. Weinshank: The experiences of Mr. Macon and Professor Kinealy are somewhat different from my own. In an opera house, which has been recently completed in Indianapolis, we designed the air admission under the seats. The foul air is being removed from the main auditorium through large vent ducts placed at the rear wall with openings at the floor levels of the main floor and balconies. An exhaust fan is placed in the attic.

All vent flues are connected to this exhaust fan and the air discharged from a large ventilator to the atmosphere. We designed this on the theory that the sound traveled with the air.

While it is true that the sound wave travels faster than the air, nevertheless, we had the experience in other buildings where

the ventilating flues were located near the stage and the acoustics was very faulty.

Some German engineers have endeavored to remedy bad acoustics in large auditoriums by stretching fine silver wires from the stage to the different parts of the auditorium. This has remedied some trouble, but not overcome the difficulty entirely.

In the large auditorium at the University of Illinois, considerable trouble was experienced with acoustics. It was claimed that the echo reached the audience almost at the same time as the voice of the speaker. On investigation, I found that the auditorium having a large cupola from the centre of the room had in the cupola a number of ventilators. The currents of air in the room would naturally flow upwards and thus deflect the sound waves and hence the echo and the speaker's voice would reach the auditorium almost at the same time.

To illustrate my statement, let us assume a condition as follows: a band is playing in a park. The public sitting on the leeward side will hear every strain of music while those sitting on the opposite side will, at times, hardly hear the music playing. While it is true that the sound waves travel faster than the air for the current of air, nevertheless, the wind has had the effect of deflecting some of the waves and hence the acoustics is impaired. At the auditorium in the University of Illinois, I closed up some of the openings in the cupola, and I have noticed an improvement, but not enough to remedy the difficulty, as there were no currents of air in the room at the time of the test.

Mr. Davis: I have always had an idea that the structural features of an auditorium had more to do with the acoustics than anything else. Take the Orchestra Building in Chicago, and that is notoriously bad, and it is just as bad in the winter time as it is in the summer time; and we all know churches, especially Gothic churches, where the acoustics is very bad indeed. Now take the Auditorium, for instance, in Chicago; that is one of the best that I have ever been in; and nearly all the air there is introduced upward through the proscenium arch. The great bulk of the air is taken out at the back, but it is introduced at a very low velocity.

Mr. Morrin: One of the instances I spoke of was a fan system of ventilation. It was a church of cruciform design, with a dome, but without any outlet, and the acoustics was very bad. The other was a theatre without any ventilation whatever, except by gravity, and when the building was cold the acoustics was awfully bad. When the theatre was warm it was very much better. Of course, when it was warm and filled with people the diffusion of air currents and lack of forced draft made the draft naturally upward. It had a dome outlet. That was closed and the experiment tried, as a member mentioned, but without any favorable results. And I am convinced that it is more the fault of peculiar construction or form of space than the matter of introducing the air and exhausting the air. I have seen the fine wire experiment tried. The most perfect experiment of that kind that I saw was in the Stock Exchange room in San Francisco some thirty years ago. The room was large, a great many members were on the floor, in a small space, and they suspended a curtain about six feet down from the ceiling all around about 6 ft. from the wall, in the 30-foot high ceiling, and it was most effective. It broke up the echoes completely. Everything was heard distinctly.

While I believe air currents do have an effect in a building, particularly in an empty space, like an empty theatre or a church, I do not think that the matter of air currents has all to do with it. I am more inclined to believe, as Mr. Davis expresses, that it is the peculiar form of the space.

Mr. Davis: As an evidence that the construction has a great deal to do with it, we all, I believe, have heard of or have seen the Tabernacle Building in Salt Lake City, that enormous building where a man can stand in one end of it and you can sit in the other end and hear a pin drop, and you can hear it perfectly, and the same is true whether there is a large crowd there or a small crowd. One man's voice spoken in a whisper you can hear at the other end. If there is a large audience the acoustics is perfect. They have no ventilation at all. It is heated by a lot of radiators around the sides. But it is not a construction of steel—it is constructed of two or three-inch planks put together with pegs and forms a regular sounding board.

TOPIC NO. 3.

The Air Washer as a Means of Humidifying the Air for Ventilation.

Mr. Morrin: That is a question that occurred to the writer, and the point in view was how will we determine the percentage of humidity that an air washer will give off with the normal temperature of water, or to what temperature is it necessary to heat the water to create a certain per cent. of humidity? I do not remember finding any data that were definite, precise and tried out that would control this point. For instance, in California our humidity is much lower than it is here. I would like to know if there are any members who have had any experience along that line or have any reliable data as to the corresponding temperature with the air washer as compared with the humidity of the air passing out through the coils.

Mr. Zellweger: From observations of the wet bulb temperatures of air and of the saturation temperatures attained by our air washer, I learned that for circulating water below the wet bulb temperatures, the air washer becomes more and more unable to saturate the air, the farther the temperature of the water is away from that of the wet bulb, but when the water temperature approaches that of the wet bulb, the air washer will be able to saturate the air according to its efficiency.

Our air washer when supplied with water at or above the temperature of the wet bulb, cools air from out doors to within 2 or 3 degrees of the wet bulb, but if the water temperature is considerably below, it can not do it. With very cold water, far below the temperature of the wet bulb, the difference will be 5 to 8 degrees.

Mr. Morrin: For instance, if you wanted a temperature of 70 degrees and there were few people present, perhaps it would be desirable to have the saturation go to 75 per cent. Now what temperature can the air washer water be, or how much vapor should be added to every thousand cubic feet of air to get that saturation?

Mr. Zellweger: The air will take up the vapor if the water is above the temperature of the wet bulb. Our air washers saturate to 90 per cent. But when the temperature of the wash water is below that of the wet bulb it will not do it, and less so,

the colder the water is. But by re-circulating the wash water it will come up to the wet bulb temperature and then the air washer will saturate to 90 per cent. If you furnish a large quantity of cold water into the washer it can not saturate so high, but if you give the air a chance to warm the circulating water up to the wet bulb, it will do it.

Mr. Morrin: In a rough experiment I have ignored the temperature of the washer water and injected by a manual adjustment a jet of steam into the air. But that was objectionable for the reason that the steam was slightly odorous from some chemical combination in the boiler feed-water and I had to abandon that method. I had no convenient way of raising the temperature of the water, so for the time I gave up the experiment. While the steam jet was blown into the plenum chamber, I could get the degree of saturation required, but the objection of the odor from the steam was quite noticeable.

Prof. Kinealy: This is one of those subjects for which you will have to go to the engineers of the manufacturers of air washers. Roughly it is about this way: For a given temperature of air and a given degree of saturation when the air enters the washer, the water will adjust itself in temperature to the temperature and degree of saturation of the air. That is to say, if you put into the air washer tank water at say 80 degrees, and the humidity outside is comparatively low, the water will be cooled faster than the air, until finally the water will reach a certain temperature, say 74, and the air a temperature say of 78. The water will remain at that temperature, 74, and the air will remain at 78 as it passes from the water. If you put water in the washer say at a temperature of 50 degrees the temperature of the air will remain at that same temperature of 74 and things will become in equilibrium again.

The amount of water that will be evaporated by the air depends upon the humidity of the air entering the washer, upon the rapidity of the velocity of the air passing through the spray-jets of water, upon the degree of fineness of separation of that water, and upon the number of gallons of water per thousand cubic feet of air passing per minute. If the humidity of the leaving air is too high, simply turn off some of the water and you will get a lower humidity of the air leaving the washer.

I think that I am safe in saying that most of the manufacturers of washers adjust the air and the amount of water so that the humidity of the air leaving the washer is between 80 and 90 per cent. It is difficult to get 90 at all times, but you can almost always count on 85 per cent. humidity of air leaving the washer.

Mr. Weinshank: Mr. President, I will corroborate the statement made by Prof. Kinealy, as he and I have made some tests in that direction. We endeavored to maintain a constant differential between the air and spray water. We accomplished this by cooling the spray water with ice and endeavored to maintain the temperature of the water at a certain temperature below that of the incoming air.

Usually in order to maintain that constant, a humidostat is placed in the air chamber or in the main duct, whose duty is to maintain this constant by either increasing the temperature of the incoming air, thus forming a greater differential between the water and the air, or increasing the temperature of the water. There are two ways of accomplishing this result; either by increasing the temperature of the incoming air by the number of rows in the tempering coil (we usually aim to put in six rows and the humidostat controls the temperature of this coil), or this humidostat operates a jet admitting steam into the water tank, thus increasing or decreasing the temperature of this spray water. One humidostat can operate either one or both methods mentioned. By this means we are enabled to maintain the desired humidity, as we are in a position to maintain the desired differential between the incoming air and the spray water.

Mr. Morrin: In regard to changing the volume of water more or less, to control the humidity involves the mechanical necessity of a waste or loss of power above and below a normal condition. That does not appeal to the average owner who has to pay high for his power; and the raising or lowering of the temperature of the water is easy to accomplish, providing you are rotating your water. But where you are drawing constantly from a supply at a fixed temperature conditions are fixed, and to vary from these conditions will involve a combination of arrangements that should necessarily be of the least cost to the owner. There are many cases on the Pacific Slope where it is

cheaper to buy water than it is to operate a pump; where the water comes from a natural, constant source, the varying of the temperature of the water would be highly impracticable.

Mr. Weinshank: I think the gentleman from California misunderstood me. The humidostat placed in the duct can do either one or the other, or both. If it is cheaper to buy water than to use it over and over again then let your humidostat control the steam admission into your tempering coil.

Mr. Morrin: We do not use tempering coils. We have no frost or freezing weather there and we do not put in a tempering coil.

Mr. Weinshank: It is a question of a very little ingenuity to raise or lower the temperature of the water if the tempering coil is not used.

Prof. Kinealy: What we try to do is to get everything working under uniform conditions. We like to wash the air at certain fixed temperatures, for we know that if we can wash the air at a certain fixed temperature and we put the water in the tank warm or cold it will soon come to a certain fixed temperature which we know, and then everything will be working uniformly. If the water is drawn off and new water put in, in a very short time the new water will come to the same temperature as before. If the fresh water is very cold it may take as long as even ten minutes, as Mr. Weinshank and I found.

Mr. Weinshank: Five minutes.

Prof. Kinealy: We put ice in the water and cooled it down to the neighborhood of 50 degrees, but it went right back again to about 68 or 70 degrees. Mr. Weinshank says in five minutes and I said ten minutes. But in either case what does that amount to in running a plant? Absolutely nothing.

Mr. Weinshank: I answered the gentleman from California understanding that the spray water is being wasted. In that case there is no need of using the same water over and over again.

Mr. Morrin: You have to pump your water into a tank, do you not?

Mr. Weinshank: Yes.

Mr. Morrin: I am speaking of eliminating the pump. In many cases it is cheaper for us to buy water than it is for us

to buy power. I am raising the point that you have no control whatever of your water; you draw it from the main constantly and let it run to waste as you use it. Now the quantity of water that passes through the air washer is fixed. If you are going to eliminate a certain per cent. of solids from the air you must use a certain quantity of water, and the temperature of that water controls your humidity, as I understand it.

Prof. Kinealy: Yes, that is right. I did not know that you were speaking of taking the water from the source of supply under a pressure sufficient to spray it. We try to supply the water under a certain head, and we try to keep that head as nearly uniform as possible in all plants. In that way we get a certain spray. Then when we get our conditions down to what we call standard conditions, we know what we can do, but if we change the temperature or pressure of the water and keep on changing we don't know what we are doing.

Mr. Morrin: Well, that is the point of the query.

Mr. T. Tait: I would like to ask if Mr. Morrin or the Professor has any data on the cost of water supply, say straight from the river or from the city supply.

Prof. Kinealy: I do not think that we have an installation where we are using water from the source of supply under pressure and allowing it to run to waste. We use the same water over and over again, and sometimes the water will be emptied from the tank or sump twice in twenty-four hours, sometimes not in two or three days. And I really do not know how much water will be required in a week or month.

Mr. T. Tait: Right along that line I have in mind an installation of air washer water that is returned to the house tank from the sump and purified by going through charcoal. That reduces the cost, but I never can get the manager to unbosom himself as to what his water rent is. That is the reason I asked for the information. The water was supplied direct to the air washer from the city mains.

TOPIC NO. 4.

The Desirability of Cast or Malleable Nipples in Radiators.

Mr. James Mackay: The question of nipples in radiators is one of great importance. There have been a great many dif-

ferent metals tried. But I am of the opinion that a good, heavy malleable iron nipple, properly prepared, is the best nipple that can be used. I am aware that there has been considerable trouble with malleable iron nipples, due to porous metal; but this has been overcome and malleable iron nipples are to-day being used with great success. There is a certain amount of resilience and elasticity in this material, that has proved very satisfactory.

TOPIC NO. 5.

Hanging Glass Ceiling in a School Room and the Ventilating Arrangements.

Mr. F. W. McGuire: I have seen a view of a school room with a hanging glass ceiling. This ceiling is about 7 ft. from floor and abutting the wall flue, where fresh warm air is introduced. It extends within a distance of about one foot from the three other walls. The foul air is removed by way of two openings on the same side as and near the fresh air inlet, one opening at the floor line, of two-thirds the capacity of fresh air inlet, and the second opening above glass ceiling in same flue as opening at floor line and of one-third the capacity of the fresh air opening. The object of the arrangement is to introduce the fresh air near the breathing line. The openings between the suspended ceiling and the three sides, other than the side where fresh air and foul air flues are located will allow the warm air as it rises along the exposed walls to warm the cold air descending along these same channels. The whole will tend to avoid any drafts and also to introduce the fresh air properly.

The principal benefit to be derived from the suspended ceiling is that it introduces the fresh air at or nearest the breathing line, and distributes it equally at its immediate introduction into the room. It does not travel to the upper part of room first and become contaminated by the foulness of the ceiling level. The impurities that may accumulate are either forced to the floor line or the upper space by way of the space along the walls, as either of their weights may determine, thereby giving a pure stratum of air at or nearest the breathing line.

Secretary Mackay: My impression would be that this arrangement would not be in conformity with the school-house laws which have been enacted, and which state definitely the height of

the ceiling of each room. I think this glass ceiling would be considered the ceiling of the room and the space above a sort of dead space which the scholars or teacher would not get the benefit of.

And then on the question of working two ventilating ducts from the same room to the same flue, even if they are different in size, my opinion would be that the upper one would work to the disadvantage of the lower one unless they were all to be of equal size and connected together and have register faces in them so that both could not be opened at the same time and so that opening the lower one would close the upper one, and opening the upper one would close the lower one. Then I think perhaps it would be feasible. But my thought is that that would not comply with the state laws, and I question if sufficient improvement would be found in the operation of the movement of the air to warrant it.

And then there is another thought, that those windows would not be hung on pivots so that they could be turned for cleaning; chalk and fine dust of the school-room from cleaning would be deposited on top of the windows, and I think it might be considered objectionable.

Prof. Kinealy: The only way to determine a thing of this sort is to try it. I do not quite see what it is expected to accomplish. We can now heat and ventilate a school-room so there will not be more than two degrees difference of temperature in any parts of the room, and there will be no drafts. When I made an investigation for the City of Boston in regard to its schools, in 1903 or 1904, I assumed that if the temperature varied more than two or three degrees the room should be considered as improperly heated; and in many rooms there was not a variation of even one degree. Once in a while I would find a room where there was a variation of three degrees. The temperatures were determined by putting thermometers in the four corners of the room and reading these thermometers every fifteen minutes all day long. There were no drafts in the rooms.

If you can do that with the present arrangements, if you can prevent drafts and have a temperature that does not vary more than two degrees in any part of the room occupied by the stu-

dents, I do not see what more you want. I do not know what more this arrangement is expected to accomplish.

The President: I think one of his ideas was to get the fresh air nearer the breathing line; I suppose from fear of the air that would ordinarily go to the top, that would mean that naturally it was becoming foul.

Mr. Morrin: I would like to ask Prof. Kinealy what the average velocity of the air was at the fresh air inlet in the schools that he inspected, if there was any difference. Which was the most favorable, the high or low velocity, as to the uniform temperature of the rooms?

Prof. Kinealy: I don't remember. We tested rooms where the velocity of the entering air was as high as 600 feet per minute, and then we tested rooms where the velocity was as low as 300 or 350 feet per minute. I do not remember the temperature of the particular rooms with those velocities. But it is possible to get good results with high velocities and it is also possible to get good results with low velocities. If you have high velocities you have got to have more than one place for admitting the air. I have found that it is difficult to prevent drafts in a school-room where the air is changed more than eleven or twelve times per hour. Yet I remember distinctly one room in a school in Boston—I commented on it in my report—where the air was changed nearly fourteen times per hour, and there was absolutely no draft. That room was getting more than its share of air, that was all.

Mr. Morrin: And getting it at a velocity that was satisfactory?

Prof. Kinealy: At a very low velocity; yes, sir.

In Memoriam

	Became a Member.	Died.
L. H. HART, New York	Sept. 1894,	Jan. 26, 1897.
JAMES W. GIFFORD, Attleboro, Mass.	Jan. 1898,	July 26, 1899.
WILLIAM McMANNIS, New York . .	Sept. 1894,	Jan. 19, 1901.
CHARLES F. TAY, San Francisco, Cal. .	Jan. 1896,	Sept. 8, 1901.
ARTHUR H. FOWLER, Philadelphia, Pa.	Jan. 1897,	June 3, 1903.
STEPHEN G. CLARK, New York . . .	Dec. 1902,	Feb. 3, 1904.
CHARLES M. WILKES, Chicago, Ill. . .	Jan. 1897,	Jan. 7, 1905.
JAMES CURRAN, New York	Dec. 1901,	Oct. 27, 1905.
HERBERT W. NOWELL, New York . .	June 1904,	Mar. 25, 1906.
ENOCH RUTZLER, New York	July 1901,	Feb. 29, 1908.
HARRY J. OTT, Chicago, Ill.	Dec. 1906,	Sept. 25, 1908.
THOMAS J. WATERS, Chicago, Ill. . .	Sept. 1894,	Feb. 25, 1909.
MAX J. MULHALL, New York	June 1909,	July 30, 1909.
WALTER B. PELTON, Dorchester, Mass.	June 1910,	Nov. 2, 1910.
R. BARNARD TALCOTT, Denver, Colo.	June 1899,	Dec. 4, 1910.
WILLIAM H. BRYAN, St. Louis, Mo. . .	July 1898,	Dec. 8, 1910.

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